AVIATION WEEK

A McGRAW-HILL PUBLICATION

June 17, 1957 50 cents

Meteor Burst Extends Range Of VHF Radio

Italians Land Sabre IVs In Tight Formation

Special Picture Report From Paris:

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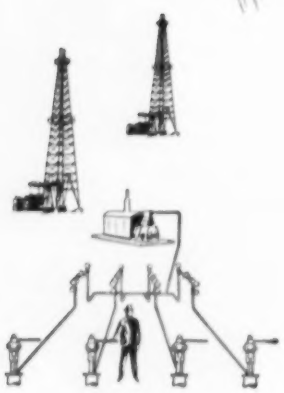

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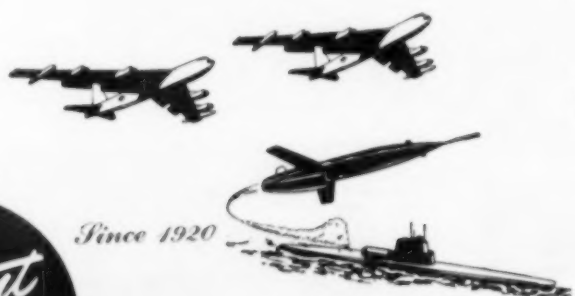

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AVIATION CALENDAR

June 17-19—National Convention on Military Electronics, Sheraton-Park Hotel, Washington, D. C., sponsored by Institute of Radio Engineers.

June 17-20—Eighth All Women's International Air Race, McAllen, Tex.-Cuba. For details, write: Miss Irma Price, Entry Chief, 242 W. 8th St., Miami, Fla.

June 17-20—National Summer Meeting, Institute of the Aeronautical Sciences, Biltmore Hotel, Los Angeles, Calif.

June 21—Jet Age Conference, Hotel Commander, Cambridge, Mass.

June 22-23—Golden Anniversary of the Air Force, New England observance, L. G. Hanscom Field, Bedford, Mass.

June 23-25—29th Annual Meeting, Aviation Distributors & Manufacturers Assn., The Broadmoor, Colorado Springs, Colo.

June 24—Soviet National Aviation Day, Moscow.

June 24-28—American Institute of Electrical Engineers, summer general meeting, Sheraton Mt. Royal Hotel, Montreal, Canada.

June 27-29—13th Annual Meeting, Institute of Navigation, Sheraton-Park Hotel, Washington, D. C.

July 2-11—24th National Soaring Contest, Harris Hill, Elmira, N. Y.

July 6-10—Eleventh All-Women Transcontinental Air Race, from San Mateo County Airport, Carlos, Calif., to North Philadelphia Airport, Pa.

July 12-13—British Lockheed International Aerobatic Competition, the National Air Races (third round) and the King's Cup Air Race, Coventry Civil Aerodrome, Baginton, England.

July 28—Third Annual Jaycee Air Fair, sponsored by Portland (Oregon) and Junior Chamber of Commerce, Portland International Airport.

July 31-Aug. 4—Eleventh Annual National Convention, Air Force Assn., and Airpower Panorama, Sheraton-Park and Shoreham Hotels, Washington, D. C.

(Continued on page 6)

AVIATION WEEK • JUNE 17, 1957

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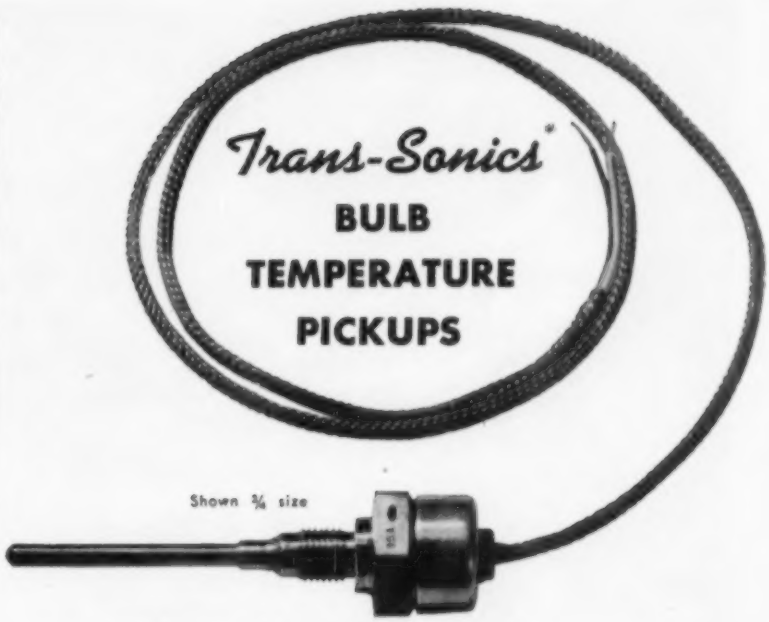

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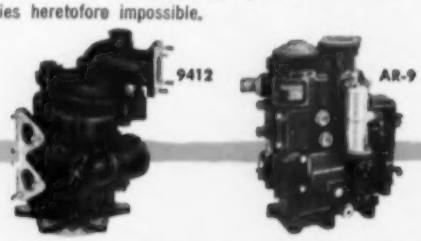

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AVIATION CALENDAR

(*Continued from page 5*)

Aug. 1-2—Second Annual Exiborama and First Annual National Photo Instrumentation Symposium, Society of Photographic Instrumentation Engineers, Ambassador Hotel, Los Angeles.

Aug. 5-10—National Naval Aviation Meeting, Institute of Aeronautical Sciences, U. S. Grant Hotel, San Diego, Calif.

Aug. 10-11—Midget Airplane Races, Oshkosh, Wis.

Aug. 20-22—Bendix-Scintilla International Ignition Conference, Sidney, N. Y.

Aug. 20-23—Western Electronic Show & Convention, Cow Palace, San Francisco.

Aug. 26-28—Gas Dynamics Symposium, Transport Properties in Gases at High Temperatures and Pressures, Technological Institute, Northwestern University, Evanston, Ill.

Aug. 31-Sept. 1—Midget Airplane Races, Ft. Wayne, Ind.

Sept. 1-15—Sixth International Aeronautical Conference, Royal Aeronautical Society and Institute of the Aeronautical Sciences, Folkstone and London, England.

Sept. 2-8—1957 Flying Display, Society of British Aircraft Constructors, Farnborough, England.

Sept. 3-14—11th General Assembly, International Union of Geodesy and Geophysics, in conjunction with International Geophysical Year, University of Toronto, Canada.

Sept. 9—13th Annual General Meeting, International Air Transport Assn., Madrid, Spain.

Sept. 9-13—Twelfth Annual Instrument-Automation Conference & Exhibit, Cleveland Auditorium, Cleveland, Ohio.

Sept. 13—Third Pacific Area National Meeting, American Society for Testing Materials, Sheraton Palace Hotel, San Francisco, Calif.

Sept. 15—1957 Garden Party and Flying Display, Royal Aeronautical Society, Wisley Aerodrome, Weybridge, Surrey, England.

Oct. 1-5—National Aeronautic Meeting, Aircraft Production Forum & Aircraft Engineering Display, Hotel Ambassador, Los Angeles.

Oct. 2-4—Tenth Annual Meeting and Forum, National Business Aircraft Assn., Cosmopolitan Hotel, Denver, Colo.

Oct. 7-9—13th Annual National Electronics Conference, Chicago, Ill.

Oct. 7-10—Triennial Inspection, Lewis Flight Propulsion Laboratory, Cleveland.

Oct. 7-12—Eighth Annual Congress, International Astronautical Federation, Barcelona, Spain. For details write: IAF, 35 Lowell Rd., Concord, Mass.

Oct. 9-11—National Fall Convention, Society for Experimental Stress Analysis, El Cortes Hotel, San Diego, Calif.

Oct. 21-22—Canadian Aeronautical Institute-Institute of the Aeronautical Sciences Meeting, Montreal, Canada.

Oct. 24-25—Fourteenth Annual Display, Aircraft Electrical Equipment, Aircraft Electrical Society, Pan Pacific Auditorium, Los Angeles, Calif.

Oct. 28-29—Third Annual Meeting, Association of the U. S. Army, Sheraton-Park Hotel, Washington, D. C.

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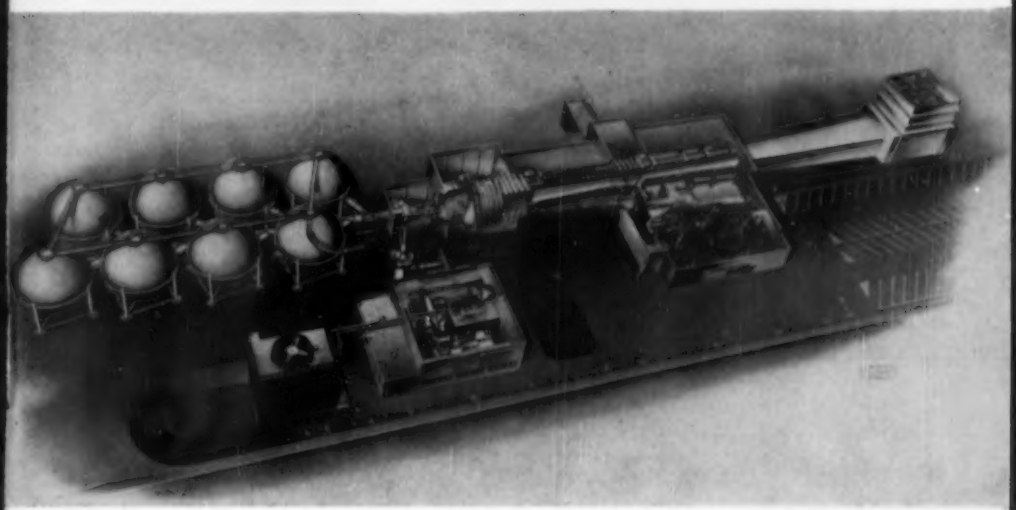

Outlet manifold, air storage tanks

this advanced wind tunnel test facility, for air speeds up to 2500 mph

The new Trisonic Blowdown Wind Tunnel constructed for North American Aviation, Inc. at El Segundo, California is the latest in the large number of wind tunnels built by Pittsburgh-Des Moines—facilities contributing greatly to America's leadership in the air. ● In NAA's tunnel, interconnected air storage spheres supply a supersonic blast of air to a 7 x 7 ft test section under precise control of the largest air regulating valve ever built. Approximately 7 tons of air per second passes through the test chamber at maximum flow, and energies of over a million horsepower are attained. ● Scale models of aircraft, rockets and missiles can be tested in the tunnel at air speeds up to Mach 3.5.

Diffuser screen, modifying air blast to muffler

Variable geometry diffuser, exterior view

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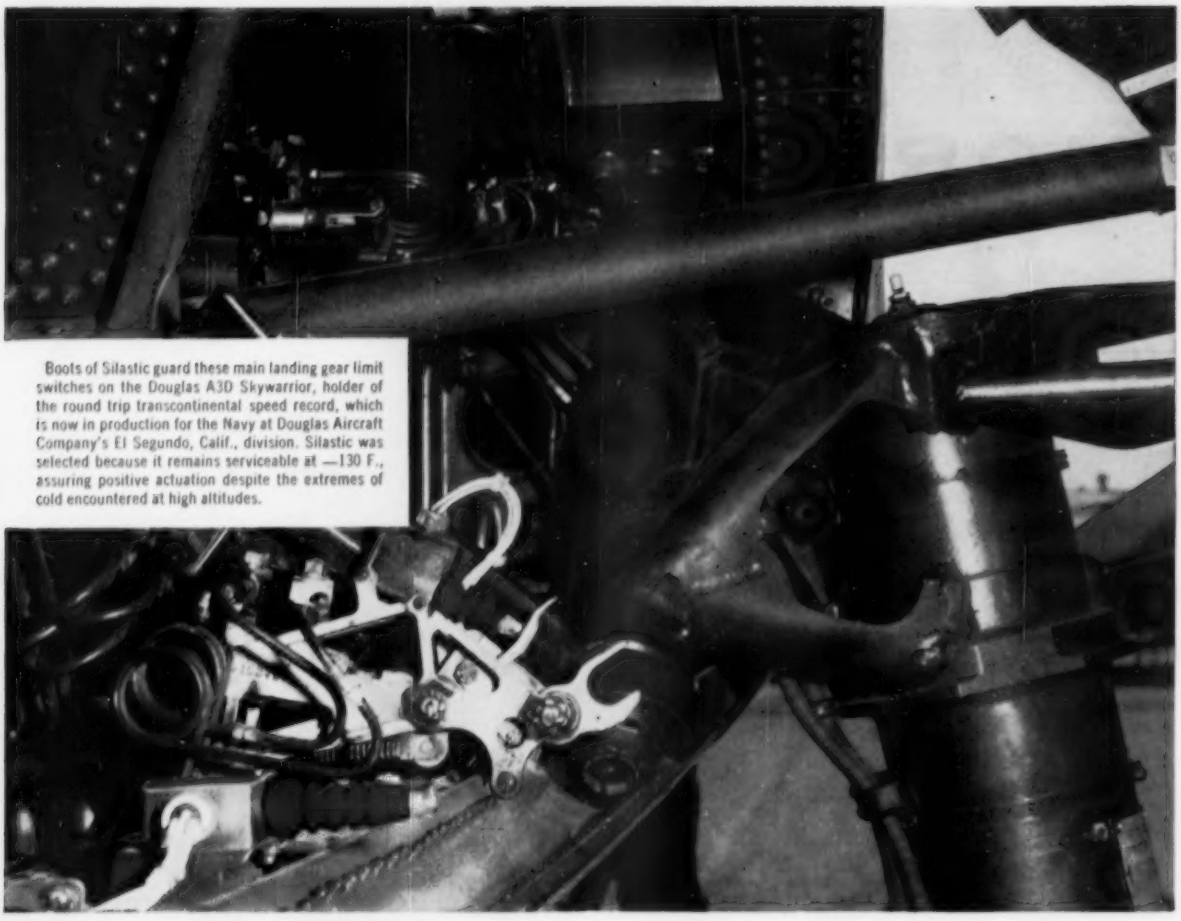

Boots of Silastic guard these main landing gear limit switches on the Douglas A3D Skywarrior, holder of the round trip transcontinental speed record, which is now in production for the Navy at Douglas Aircraft Company's El Segundo, Calif., division. Silastic was selected because it remains serviceable at —130 F., assuring positive actuation despite the extremes of cold encountered at high altitudes.

SILASTIC remains resilient down to –130 F

SILICONE RUBBER

Parts molded of Silastic*, the Dow Corning silicone rubber, retain their shape and flexibility over a 630 degree temperature span. And Silastic parts remain reliable in spite of weathering, ozone, and corona, and have very low compression set. All leading rubber companies now supply moldings, sponges, or extrusions of Silastic. A variety of shapes, colors and physical properties, including fuel and solvent resistance, are available.

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Typical Properties of Silastic for Molded Parts

• Temperature Range, °F	—130 to 500
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• Compression set, %, @ 300 F	15 to 40
• Hardness range, durometer	20 to 90
• Dielectric strength, volts/mil	400 to 500
• Oil resistance	Dependent on type of oil

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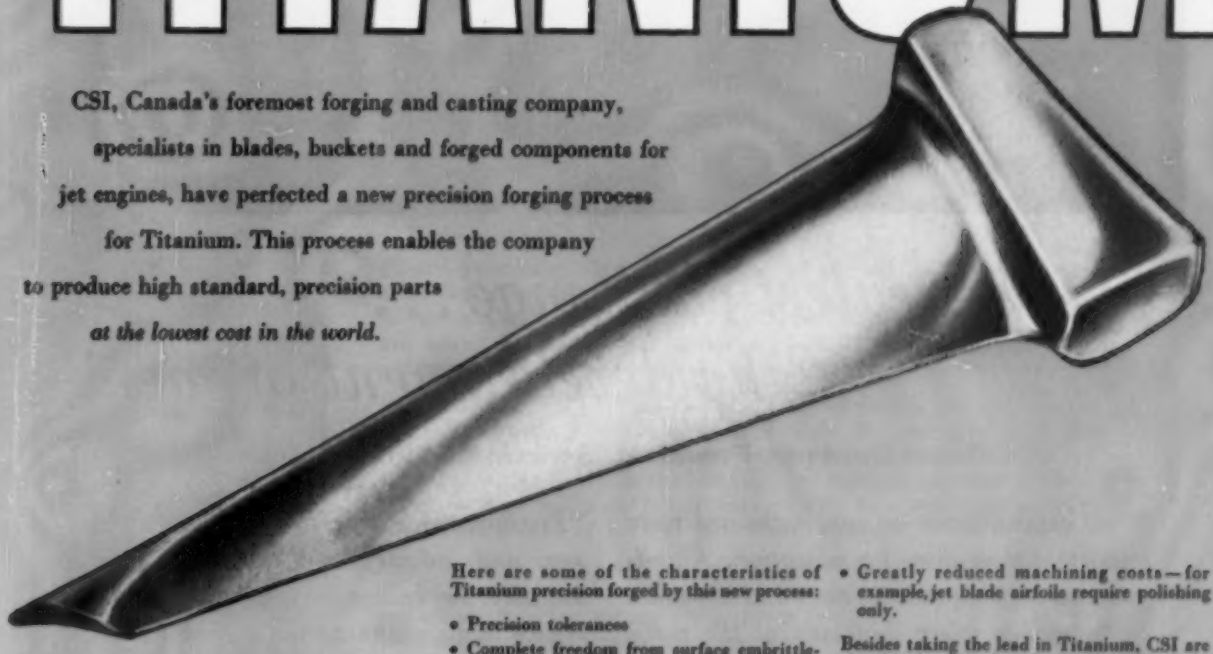

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- **Precision tolerances**
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- **Excellent surface finish.**
- **Consistent quality maintained.**
- **Greatly reduced machining costs—for example, jet blade airfoils require polishing only.**

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BLIND FLYING – 'COPTERS CAN DO!

Pilots generally have been skeptical of the practicability of adapting blind flying techniques to helicopters. At the Army Aviation Center, Ft. Rucker, Alabama, however, 'copter pilots are being trained to fly under zero-zero conditions, using an adaptation of conventional GCA equipment.

Meanwhile, CWO Clifford Turvey, Project Officer for the Instrument Program, is working closely with Bell engineers in the development of new instrument flight equipment specifically for helicopters. He predicts that unqualified success will crown these efforts — and that soon helicopters will fly as a matter of course, regardless of the lack of visibility and ceiling.

Mr. Turvey, a veteran of Medical Corps service in Europe during World War II, graduated in 1951 with the second class of Army rotary-wing pilots from Ft. Sill, and flew hundreds of missions of every conceivable sort during 16 months in Korea. He is qualified to fly all types of Army helicopters, although he reports that of the more than 2,500 hours he has logged, most of them have been in Bells.

Helicopter flight and mechanical training are available to qualified personnel at the U. S. Army Aviation School, Ft. Rucker, Alabama.

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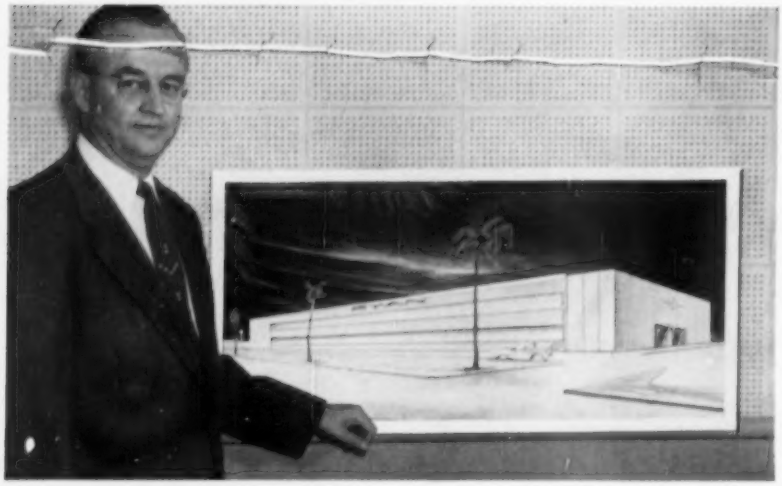
REPORT FROM RYAN

New Engineering Opportunities Created as Ryan Projects Mushroom



FRANK W. FINK, RYAN VICE PRESIDENT AND CHIEF ENGINEER inspects architect's drawing of new Engineering and Research Center.

New Engineering and Research Center To Meet Ryan's Expansion

Construction of a modern two-story, engineering and laboratories building has begun at Ryan, to meet the company's expanding work in Jet VTOL—Automatic Navigation—Jet Drones—Missile Guidance—Jet Metallurgy—Rockets.

The new facility will provide additional quarters for many of the 1000 employees in Ryan's fast-growing engineering division. It will also house complex, new chemical, metallurgical, instrumentation, environmental and autopilot equipment.

With one in six Ryan employees in engineering, this division has tripled in three years. Its mushrooming growth reflects Ryan's increased importance as a research facility in aerodynamics, propulsion and electronics.

RYAN ENGINEER "zooms" straight up in unique rotatable cockpit.

Vertical Flight Probed with New VTOL Cockpit

Shortest way into the sky is straight up—in the Ryan Vertijet. To probe this new realm of flight without becoming airborne is a trick performed daily by Ryan engineers. Their secret? A rotatable cockpit connected with electronic computers.

Ryan's flight simulation laboratory is a prime tool in the test of new aircraft designs. Both the Vertijet and the subsonic, turboprop-driven Vertiplane are put through their paces via earthbound flight test. Ryan leadership in this revolutionary new concept of flight is based upon 2¼ million manhours of VTOL research and development. It is another example of how Ryan builds better.

Ryan Automatic Navigator Guides Global Flight

An advanced system of aerial navigation, designed for high speed, long range flight, has been developed by Ryan electronics engineers, working under sponsorship of the Navy's Bureau of Aeronautics.

Designated AN/APN-67, the new navigator is the lightest, most compact, self-contained electronic navigator in production. Developed to meet military needs, it will also meet commercial jet flight requirements.

The system provides pilots and navigators with continuous information on longitude, ground speed, ground mileage, drift angle and ground track. It is accurate and instantaneous. Requires no computations, ground facilities or wind data.

AUTOMATIC NAVIGATOR guides pilots with single instrument (above).

Ryan has immediate career openings for engineers

Look to the future. Look to Ryan...where you can grow with an aggressive, forward-looking company. You'll find a variety of stimulating projects. Ryan engages in all three elements of modern flight vehicles—airframes, engines to propel them and electronics equipment to guide them.

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Pressure calibration is achieved by balancing a controllable air pressure against the force generated by a weighted piston. Simple combinations of different piston-cylinders and weights provide four ranges within the limits of 0.3 to 50 psi.

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Used as a gage type instrument, all you need is a dry air supply, a regulator, and the device being calibrated. When the 6-201 is used as an absolute device, its glass cover can be evacuated through a pressure fitting.

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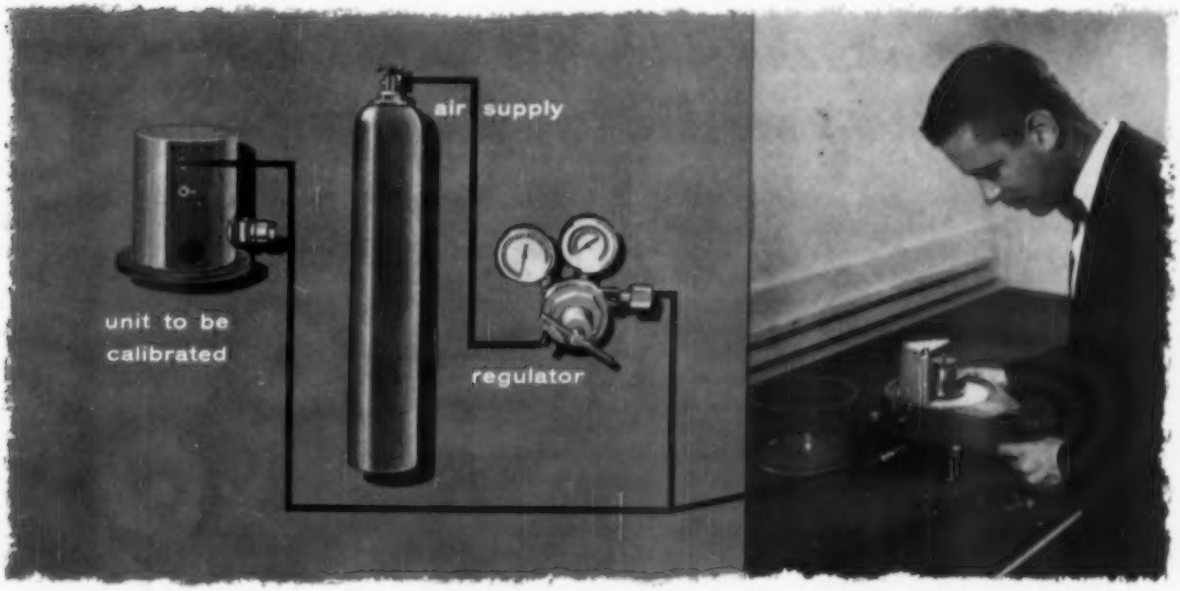

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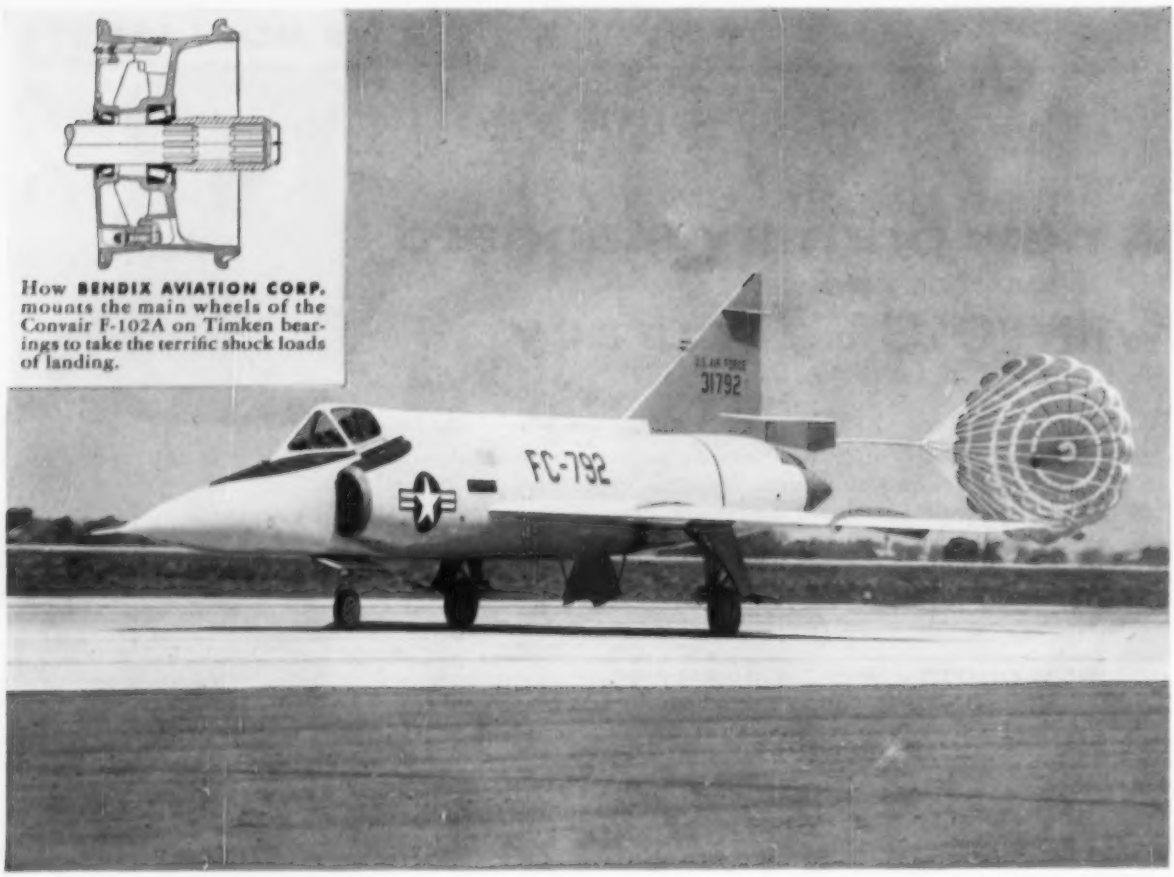
How **BENDIX AVIATION CORP.** mounts the main wheels of the Convair F-102A on Timken bearings to take the terrific shock loads of landing.



New jet hits the silk – **TIMKEN® bearings take terrific landing impact**

EVEN after the drag chute pops out, there's a tremendous landing wallop when Convair's supersonic F-102A hits the runway. The supplier of the main wheels, Bendix Aviation Corporation, specified one make of bearing—Timken® tapered roller bearings—to handle the instantaneous shock loads of landings.

Timken bearings are case-carburized to give them hard, wear-resistant surfaces over tough, shock-resistant cores. And full line contact between rollers and races gives them extra load-carrying capacity. The tapered design of Timken bearings enables them to take any combination of radial and thrust loads, as in cross wind landings.

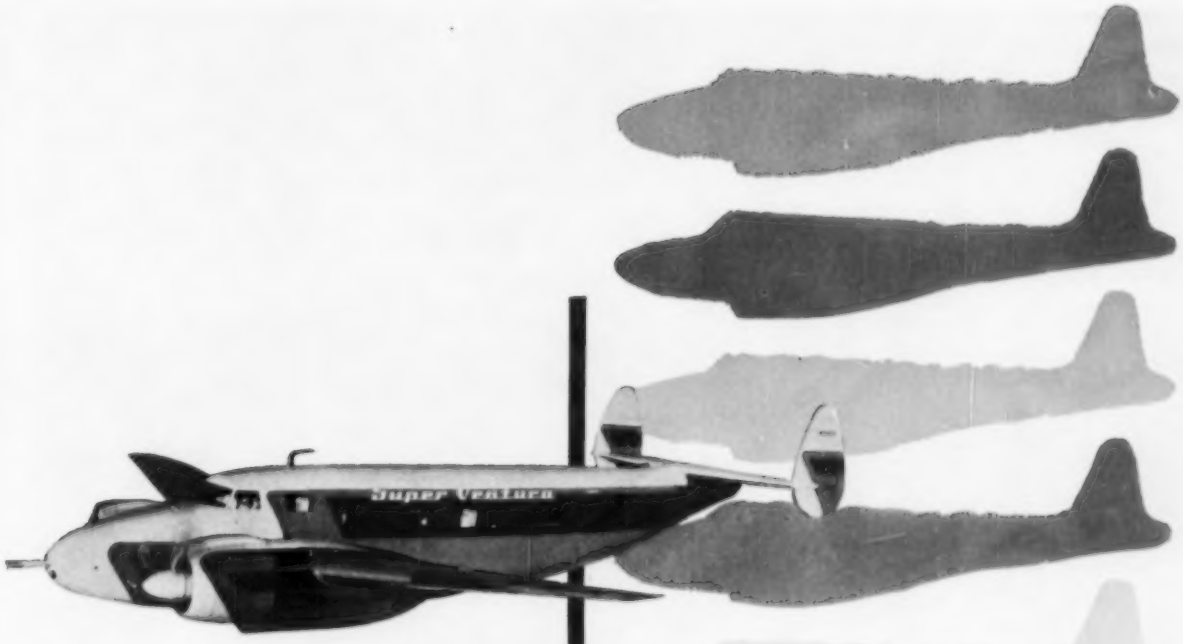
Friction is practically eliminated by Timken bearings. They are designed by geometric law to give true rolling motion, and their precision manufacture keeps them true to their design. Shafts and housings are held in rigid alignment making closures more effective. Dirt stays out; lubricant stays in. And to maintain the highest quality, we even make our own steel. No other American bearing manufacturer does.

To get all these advantages in the bearings you buy, specify Timken bearings. Look for the trade-mark "Timken" on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.

TIMKEN TAPERED ROLLER BEARINGS ROLL THE LOAD

TRADE-MARK REG. U. S. PAT. OFF.



leading in high speed executive plane sales

Twenty-one Super Venturas have been sold to some of this nation's major companies since the first delivery was made in May, 1956. No other airplane in its class has sold as well. There is a reason why — no other executive airplane has all the exceptional features of the Super Ventura. Compare speed, range, safety, cabin luxury, single engine performance and all the other comparative categories and you will agree — the Super Ventura is the finest executive airplane on the market today. Only two of the outstanding features of the Super Ventura is its 300 miles per hour plus speed and its 2,000 mile range. There are many more.

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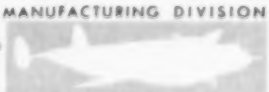

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R. B. HURLEY, holder of degrees from the University of California and University of Southern California, is a Design Specialist at CONVAIR-*POMONA*. He is a nationally-recognized author and lecturer in the field of transistors.

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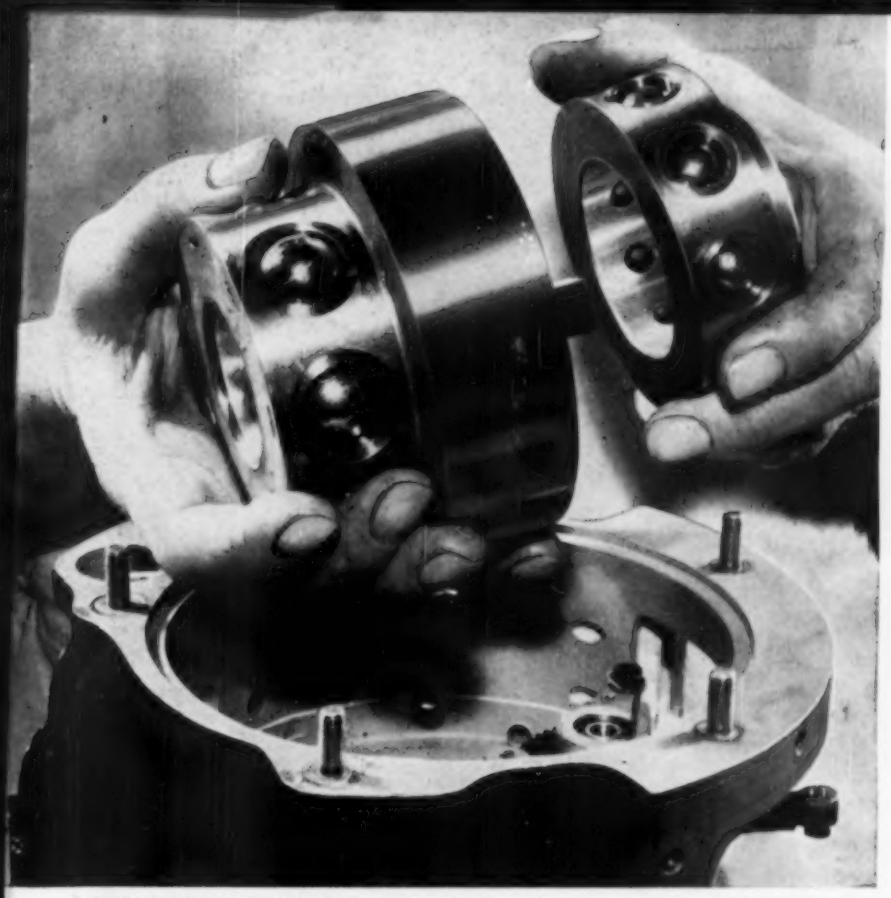
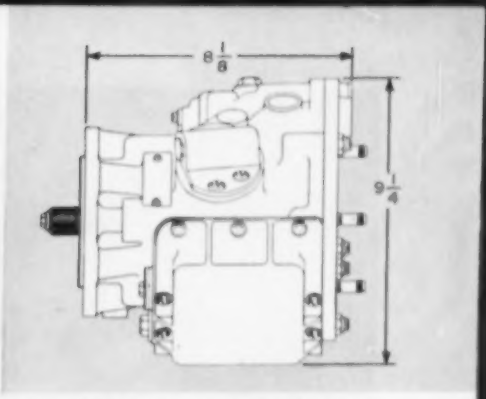
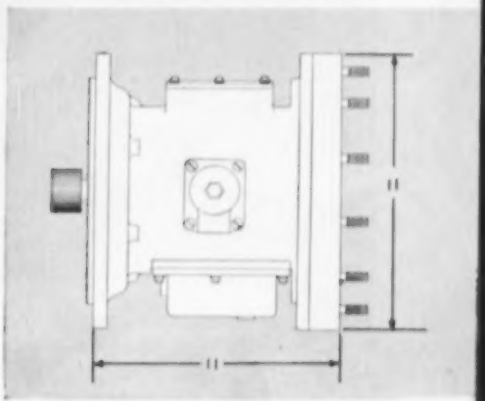


MECHANICALLY SIMPLE ball piston unit shown being assembled in 20 KVA drive replaces conventional cylindrical pistons, connecting rods and bearings. Its use results in a more compact, lighter weight constant speed drive with fewer moving parts.



LIGHTWEIGHT 20 KVA DRIVE weighs 35 lbs. It delivers rated 32 hp over full input speed range of 4300 to 8300 rpm.



COMPACT 40 KVA DRIVE weighs 52 lbs. It delivers 63 hp over full input speed range of 3700 to 8300 rpm.

GENERAL ELECTRIC DEVELOPMENT SHOWS

How Ball Pistons Cut Size and Weight, Simplify Hydraulic Drive Design

General Electric Hydraulic Constant Speed Drives offer outstanding space and weight savings and design simplicity for any 400-cycle a-c electric system. You can combine these drives with any aircraft generator for use on piston, turboprop, or turbojet engines.

UNIQUE BALL PISTON DESIGN is the key to the small size, lightweight and mechanical simplicity of these drives. Operating on the simplest of principles, this radial piston hydraulic transmission uses precision steel balls in place of pistons, connecting rods and bearings. Extensive testing and thousands of hours of operational flying have proven this unit maintains high efficiency and reliability.

FEWER MOVING PARTS are required with this design. For example, since the balls are free in the cylinder and roll on the race, no separate bearings are needed to prevent contact friction, and the usual piston and connecting rod bearings are eliminated. The use of a journal bearing further cuts size and complexity. What's more, the mechanical governor system, which provides steady state speed control within ±1%, is an integral part of the transmission. Easily accessible parts simplify maintenance.

COMPACT AND SELF-CONTAINED, a typical 20 KVA drive measures only 8⅛ inches long and 9¼ inches in diameter. It weighs 35 lbs. A typical 40 KVA drive measures 11 inches by 11 inches and weighs 52 lbs.

Fine frequency control to ±1/10% and automatic paralleling can be provided with all General Electric Hydraulic Constant Speed Drives. For more information on these drives contact your General Electric Aviation and Defense Industries Sales Office, or send coupon for bulletins.

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- ☐ **Descriptive bulletin, GEA-6274**
- ☐ **Theory of Operation, GET-2480A**
- ☐ **immediate project** ☐ **reference only**

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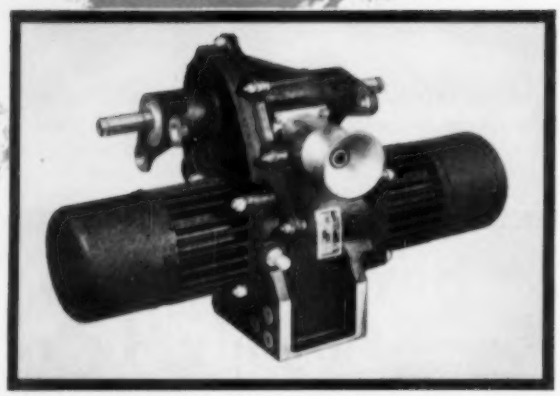
WESTERN GEAR–designed wing flap actuator chosen for the 'Argus,' Canada's largest plane



This dual motor powered actuator, designed and built by Western Gear is light weight, compact and thoroughly reliable. Both the motors and gear box are Western Gear manufactured.

Canadair engineers required a light weight, compact, thoroughly reliable actuator for the wing flap system on the ARGUS, Canada's newest and largest aircraft. The Western Gear design was accepted because it excelled in meeting these qualifications. The experience of 40 years' service to the aircraft industry, coupled with knowledge and facilities for both *electrical* and *mechanical* power transmission equipment design made this possible. The Western Gear engineering team, including our Electro Products Division which designed and built the twin motors, worked hand in glove with the gear engineering experts in our Aircraft Division. Whatever your problem, whether it is rotary electrical equipment or gear drives, complete systems, or equipment combinations such as on the ARGUS, you will find Western Gear Aircraft Industry Specialists ready to provide you with the RIGHT answer. Ask for their recommendations now. Write General Offices, Western Gear Corporation, P.O. Box 182, Lynwood, California.

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June 17, 1957

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Vol. 66, No. 24

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EDITORIAL

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COVER: As a climax to its exhibition, Italian air force acrobatic team flying Canadair Sabre IVs at the Paris Air Show made a slow flyby in a tight diamond formation with speed brakes extended. Then, keeping same tight formation, the team made entire landing approach, lowered landing gear simultaneously and then touched down, still holding tight formation. Slot man lands first. His main wheels are just on the ground, nose wheel still in the air, in the picture. The number 2 and 3 wingmen hold main gear at the same height above runway and touch down simultaneously next. Leader lands last. (For other acrobatic pictures, see pages 50, 51 and 52. Other show pictures start on pages 56 and 76. Cover photo by Russell Melcher.)

Picture Credits:
50, 51, 52, 56, 57, 58, 59, 76, 77, 78, 79—Russell Melcher; 27, 34, 88—Wide World; 37—Howard Levy.

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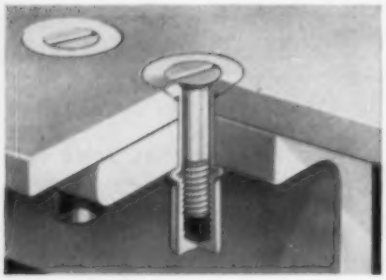
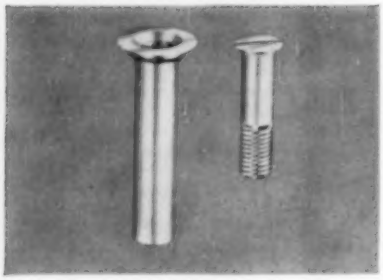
At B. F. Goodrich, sealings are unlimited for liquids, gases and solids

PROBLEM—Designing the Grumman F11F-1 Tiger, using skin panels for integral wing tanks, required a strong leak-proof blind fastener.



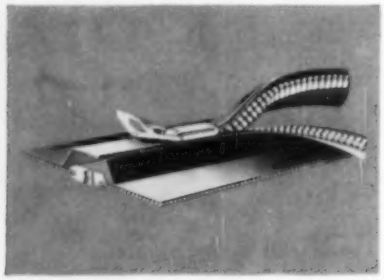
SOLUTION—Installed from one side, a Seal-Head Rivnut with rubber "O" ring provides a fuel-tight seal, withstands temperatures from −65° to + 225°F.



B. F. Goodrich Seal-Head Rivnut is approved for primary structure. Special high tensile screw adds reinforcement after installation.

PROBLEM—Baggage compartment panels in Lockheed's Super Constellations had to seal out air, yet open easily for servicing of equipment.

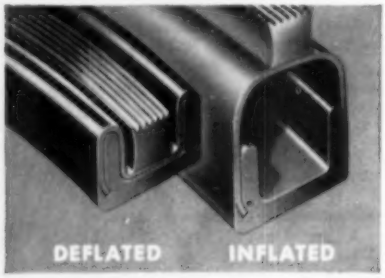
SOLUTION—B. F. Goodrich baggage panels with Pressure Sealing Zippers zip open quickly, form flexible, air-tight bulkheads that withstand abrasion, impact.



B. F. Goodrich Pressure Sealing Zippers have molded rubber lips that overlap with hairline precision. Three styles, two sizes, solve tricky sealing problems.

PROBLEM—The Lockheed F-104A required a lightweight canopy seal adaptable to compound curvatures and offering high flexibility at low temperatures.

SOLUTION—B. F. Goodrich seal inflates without stretching, gives longer service life and uniform sealing pressure at all points.



Ribbed striker bead is lifted by quick-action, reinforced diaphragm. When inflation pressure is released, seal snaps into relaxed position without vacuum assistance.

Whether your sealing problem concerns canopies, bomb bays, interior compartments, air ducts, access ports, aileron gaps or other areas, consult B. F. Goodrich Aviation Products. Our engineers have the technical knowledge and experience background to help you work out a successful solution.

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EDITORIAL

Facing Fiscal Facts

After two years of financial legerdemain with its airpower budget the executive branch of the government has come to its day of reckoning. It is no longer possible to ignore the fiscal facts involved in the airpower program.

Main fact is simply that the Defense Department finds itself some $4 billion short of the funds required to finance the airpower force levels it has repeatedly promised the American people it would maintain. Now, it must either ask for an additional $4 billion to close this financial gap, or it must cut drastically both the quantity and quality of aerial weapons and the facilities required to support them in combat units.

Vindication for Critics

The chain of events precipitated by Defense Secretary Charles E. Wilson's memorandum of May 22 (AW June 10, p. 33) setting expenditure ceilings and ending the partial financing policy on major weapons procurement, has indicated clearly the validity of the charges made during the past two years that the airpower budgets proposed by the executive branch of the government were grossly inadequate to support the strength levels promised. The current fiscal crisis in the Pentagon proves conclusively that the critics were right and the defenders of this airpower fiscal policy were either financially naive or deliberately deceptive.

When the day of financial reckoning finally arrived the administration was faced with a choice of finally making the drastic cutbacks in aerial weapons procurement that its critics had charged would be the inevitable result of its fiscal policies or asking for a rise in the authorized national debt level. It has chosen to make the cuts and retain the present debt level.

Cutback Details

Thanks to a courageous and forceful memorandum by Air Force Secretary James H. Douglas the full impact of these cuts has been spelled out in unmistakable detail. According to the Douglas memorandum, the new administration fiscal policy would:

"Require major reprogramming and reduction of fiscal year 1958 and prior procurement programs or a substantial supplemental appropriation. . . . If we are required to adhere to the expenditure objective for Fiscal 1958 large scale terminations and stretch-out of contracts against these programs would be necessary. We would need to eliminate some $4 billion dollars of programmed weapon systems in Fiscal 1958 and prior programs."

Most important are the vital weapon system programs that would be stretched out dangerously close to the point of technical obsolescence. Secretary Douglas confirmed in his memorandum that the Boeing B-52 jet bomber and its KC-135 jet tanker, the Convair F-106 supersonic all-weather interceptor, the Republic F-105 Mach 2 fighter-bomber, the Lockheed F-104 Mach 2 interceptor and some missile schedules have already been either stretched out or cut back.

In addition it appears that the Convair B-58 supersonic bomber program would be in for a major cutback during Fiscal 1958. Mr. Douglas also points out that no provision has been made for further financing of the Republic XF-103 dual cycle engined interceptor, the Bell Rascal air-to-ground supersonic missile and the Navaho Mach 3 intercontinental ramjet missile.

And all advanced gas turbine powered transport development—so vital to the logistics of the intercontinental ballistic missile program, Strategic Air Command and the Army—has been chopped off because of lack of money.

The Cost of 'Economy'

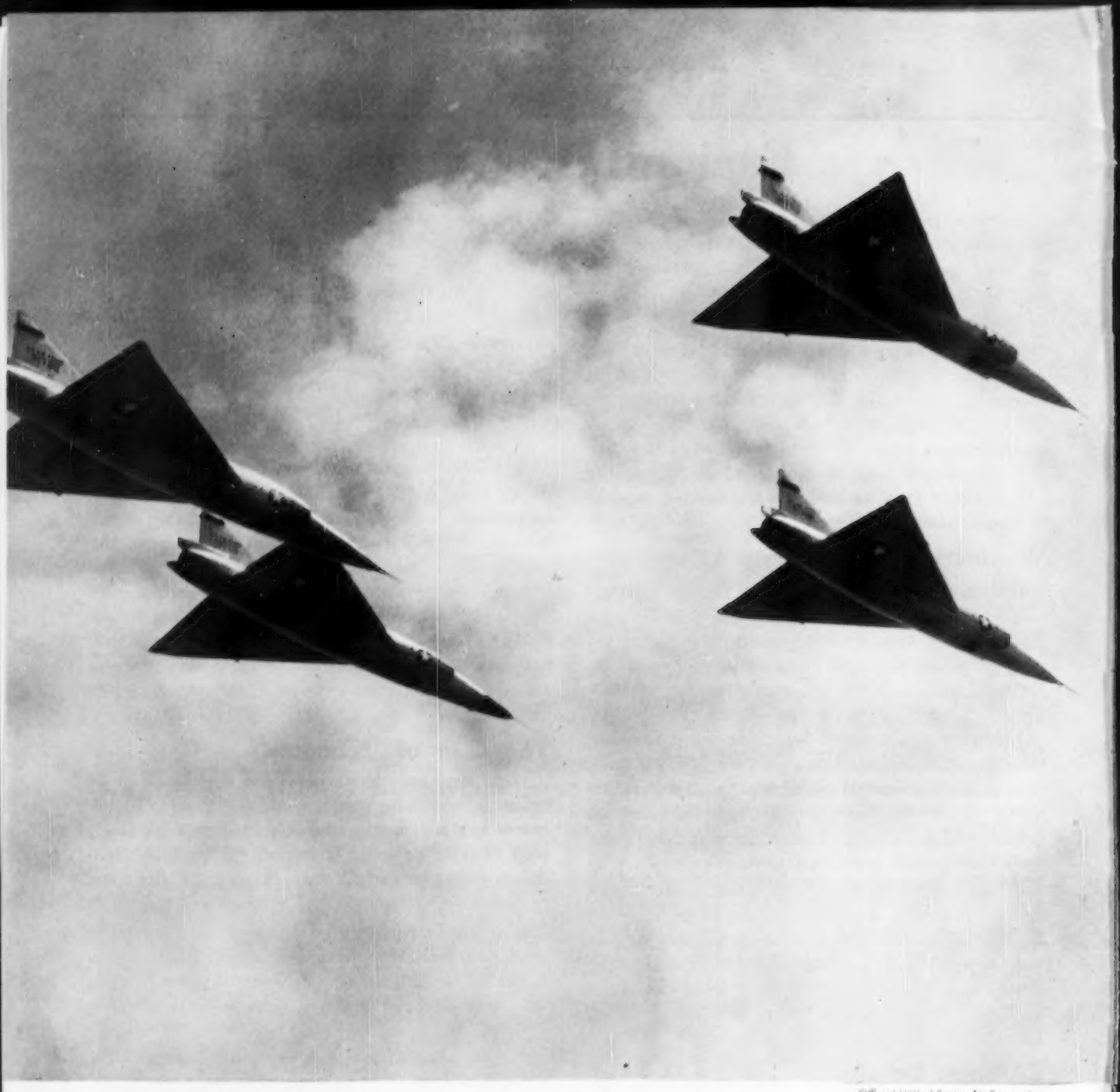
These large scale terminations and stretch-outs of $4 billion in weapons contracts would cost close to $1 billion in termination costs alone for which not one single piece of hardware would be received. Close to a billion dollars would be washed down the drain in the name of "economy."

It is clear from Secretary Douglas' detailed memorandum that the administration's proposed fiscal policies would cut the guts out of the current airpower program at a tremendous cost in wasted funds and in an infinitely more precious commodity—irreplaceable wasted time.

Even if adequate remedies were forthcoming in subsequent budgets, it would take years to recover from the technical and industrial effects of this current fiscal policy. These years could easily provide the interval during which the hard driving Russian technology opened a significant gap of leadership in the air that would be disastrous for western policy.

What we have warned against for two years has finally come to pass, and American airpower is facing its gravest crisis. A nation whose national existence and foreign policy is based on the foundation of superior airpower is now being offered a choice of destroying that strength by the stroke of a Pentagon pen or facing up to the facts and paying the airpower bill in full.

—Robert Hotz



Official United States Air Force photo

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Charles S. Thomas, former Secretary of the Navy, a director, Lockheed Aircraft Corp., Burbank, Calif.

Adm. Joseph James Clark (USN, ret.), a director, Induction Motors Corp., Westbury, N. Y.

Dr. James A. Marsh, president, and **Richard H. De Lano**, executive vice president, Systems Laboratories Corp., Los Angeles, Calif.

Ralph H. Walker, president and treasurer, Lawson Machine and Tool Co., Malden, Mass. Also: **Ralph E. Stevens**, vice president.

Theodore A. Smith, executive vice president, Industrial Electronic Products, Radio Corporation of America, New York, N. Y. **Arthur L. Malcarney** succeeds Mr. Smith as executive vice president, Defense Electronic Products.

David E. Postle, vice president-research, Mohawk Airlines, Inc.

Dean P. Stowell, vice president-manufacturing (acting capacity), Canadair Ltd., Montreal, Canada. Mr. Stowell replaces **Robert A. Neale** now on leave of absence.

Eric Tyler, vice president-sales and service, Decca Radar, Inc., New York, N. Y.

Dr. Lester L. Weil and **Keith E. Rumbel**, vice presidents, Atlantic Research Corp., Alexandria, Va.

Maj. Gen. Robert J. Wood has been assigned to the Office of the Army Chief of Research and Development, Washington, D. C. **Brig. Gen. Sam C. Russell** succeeds Gen. Wood as commanding general, U. S. Army Antiaircraft Artillery and Guided Missile Center and Commandant, U. S. Army Antiaircraft Artillery and Guided Missile School, Fort Bliss, Tex.

Honors and Elections

J. V. Naish, executive vice president of Convair Division of General Dynamics Corp., has been awarded an honorary Doctor of Laws degree from Fordham University.

Brig. Gen. J. Stanley Holtoner has received the Legion of Merit from Gen. Thomas S. Power, commander of the Air Research and Development Command, for "his outstanding service while commander of ARDC's Air Force Flight Test Center, Edwards AFB, Calif., and his achievements and contributions in the field of military flight test . . . his direction and personal participation in the flight tests of the century series fighter aircraft. . . ."

Changes

George S. Schairer, director of research, Boeing Airplane Co., Seattle, Wash.

Gordon C. George, manager-sales, flight Propulsion Laboratory Dept., General Electric Co., Cincinnati, Ohio.

Herb Caldwell, assistant general manager-Navy projects, Lockheed Aircraft Corp., Burbank, Calif. Also: **D. J. Gribbon**, executive assistant to the executive vice president, and **C. S. Wagner**, manufacturing manager.

INDUSTRY OBSERVER

► Vanguard launching vehicle, minus the second and third stage engines and the satellite itself but powered by General Electric's first stage engine, will be fired in the near future from Cape Canaveral, Patrick AFB, Fla. This will be first attempt to "fly" the complete airframe and the first flight test for the General Electric engine.

► **Electrically charged aircraft are being considered by researchers as a means of repelling ionized air particles during very high speed flight. The charge would serve to reduce the amount of air striking the aircraft, lower skin friction and aerodynamic heating.**

► Convair's Model 24 flying boat anti-submarine-warfare aircraft project (AW Mar. 4, p. 23) is scheduled to get under way late this month. New design group is being formed at San Diego with engineers drawn from other projects. Convair has not yet received a formal production contract for the aircraft, but negotiations with the Navy are proceeding. Convair design won competition over Martin and Grumman entries.

► **Lear-Grand Rapids' Wings Level Bombing System has been successfully tested on a B-47 at Air Proving Ground, Eglin AFB, Fla. WLBS is an advanced version of the LABS system. Lear also is developing a special weapons bombing system for the Navy, designated the Aero 26.**

► Research is being pushed at North American Aviation's Missile Development Division, Downey, Calif., on controllable etchants for chemical milling of wide range of high temperature materials, including Inconel-X and some of the Hastalloys, to bypass production difficulty in machining the heat-resistant alloys.

► **Manufacturers who will supply avionic equipment for Martin's Titan intercontinental ballistic missile are requested to design an extraordinary degree of ruggedness into the equipment so that shock mounting can be eliminated and top operating reliability still be insured. However, final decision on whether shock mounts will be eliminated for particular installations rests with equipment manufacturers.**

► Bell X-14 VTOL uses an Armstrong-Siddeley Viper turbojet engine with a rotating tailpipe to lift it from the ground in conventional attitude. The Viper is being supplied through Curtiss-Wright.

► **Lockheed has eased pitch control problem on the F-104 through use of an automatic warning device and control. Twin ignition system will be employed to help correct problem of relighting F-104's General Electric J79 engine after flame-out. Company is now putting the aircraft through a series of spin, engine, firepower and aerodynamic tests prior to USAF's accelerated service testing to prove F-104's combat capability.**

► McDonnell modification of an F-101A testbed involves wrapping a second skin around the mid fuselage to improve the side and bottom contours and eliminate the bulges of engine nacelles. Modification is aimed toward improving the Voodoo's speed performance and reducing the turbulence around the tail area.

► **Leduc 0.22 has begun the second stage of its flight test program, using its ramjet engine for the first time. All previous flights had been powered by the aircraft's Snecma Atar turbojet which is contained within the ramjet unit. Aim of second stage tests is to approach the Mach 2 speed range. Second Leduc 0.22 is now being manufactured.**

► Lycoming growth goals are 1,200 eshp. for the T53 and to 2,200 eshp. for the T55 in turboprop installations. T55 is now rated at 1,650, the T53 at 1,005 eshp.

► **Marquardt Aircraft Co. will design and build afterburners for Fairchild's 2,000-lb. thrust J83 turbojet engine.**

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Washington Roundup

Quesada Takes Over

Watch for public announcement early this week that Edward P. Curtis has submitted his resignation to the White House as special assistant to the president for aviation facilities planning. Resignation became effective on Saturday. Appointment of Lt. Gen. Elwood Quesada as his successor, first predicted by AVIATION WEEK (May 27, p. 25), was scheduled to take place immediately after the effective date of the resignation. Gen. Quesada has been working closely with Curtis during the past few weeks in order to prevent any disruption in progress toward implementing the Curtis proposals for handling the air traffic control program. Curtis will return to his former position as vice president of Eastman Kodak Co.

Airspace Tangle

Latest example of unilateral control of airspace occurred recently when the Navy arbitrarily closed the Miami, Fla.-Wilmington, N. C., civil airway without any prior notice during President Eisenhower's cruise aboard the aircraft carrier Saratoga off Florida. First news airlines received of the Navy's action was pre-emptory notice directing Eastern and National flights northbound from Miami to proceed to the inland airway at Jacksonville.

High Altitudes Pre-Empted

First map showing conflict between civil airways and military airspace reservations will be made public by the Civil Aeronautics Administration shortly. It will show that military services have already pre-empted about 80% of the airspace above 20,000 ft.—an area in which civil jet transports will need new airways. Map will also show overlap between airspace reservations of USAF and Navy.

Soviet Satellite First?

Look for the Soviet Union to beat the U.S. by as much as a year in the race to launch the first earth satellite. Alexander Nesmeyanov, president of the Soviet Academy of Sciences, says Russia will launch its satellite "within the next few months." A Washington source narrows that estimate to the month of July.

First launching of an instrumented U.S. satellite, originally scheduled for September, may now be delayed up to a year (AW May 27, p. 25). Richard W. Porter, chairman of the National Science Foundation's technical panel on the Vanguard program, says "there is a probability of at least one successful launching . . . before the end of 1958."

Russell Leaves BuAer

Rear Adm. James S. Russell, chief of Navy's Bureau of Aeronautics for the past two years, has been named deputy commander-in-chief of the Atlantic Fleet. Shift also brings a promotion to vice admiral. Adm. Russell will be succeeded by Rear Adm. Robert E. Dixon, former assistant chief of BuAer in both research and development and plans and programs. From July, 1956, until last February, he commanded the Taiwan Patrol Force.

The shift also calls for the promotion of Rear Adm. William A. Schoech, who served as assistant chief for research and development under Adm. Russell, to deputy chief of BuAer. In other moves, these men are moving into BuAer from outside posts:

- **Rear Adm. Leonidas D. Coates, Jr.**, as assistant chief for research and development.
- **Rear Adm. Wellington T. Hines** as assistant chief for procurement.
- **Rear Adm. D. J. Welsh** as assistant chief for plans and programs.

Round Robin Plans

USAF Secretary James H. Douglas has set an August 1 deadline for Air Research and Development Command, Military Air Transport Service and Air Training Command to submit a coordinated plan for the round robin headquarters move that will shift ARDC from Baltimore to Washington, MATS from Washington to Scott AFB, Ill., and ATC from Scott to Randolph AFB, Tex. (AW June 10, p. 23). After August 1, Air Training Command will have 120 days to accomplish its move, which will touch off still another transfer, with the Aviation Medical School making way by shifting from Randolph to Brooks AFB, Tex. ARDC and MATS will move later.

CAA Global Look

Change in top level organization of Civil Aeronautics Administration's foreign aviation activities reflects expanding global markets for civil aircraft and gives new impetus toward ultimate standardization of airways facilities and operating methods throughout the world. The new office of International Cooperation, which has been organized to centralize all CAA foreign aviation functions under one head, will embrace a Technical Assistance Division, an International Civil Aviation Organization Division and the Flight Operations and Airworthiness Division. The OIC will be headed by Raymond B. Maloy as director of CAA's foreign programs.

Land or Air?

Lt. Gen. James M. Gavin, Army chief of research and development, took public issue with USAF once again last week over what is needed to deter and win wars. In the missile era, Gen. Gavin told the Senate Appropriations Committee, the "greatest deterrent" will be missile defense against attack rather than the threat of retaliation through strategic airpower.

Gen. Gavin made the statement during a defense of the Army's plan for an anti-missile and its right to use it. In earlier testimony before the House Appropriations Committee, the then Air Force Secretary Donald A. Quarles agreed with Gavin that an effective anti-missile system is feasible but said its development would be so costly that it might be better to channel the funds into offensive missiles to provide a "deterrent" type defense (AW May 20, p. 30).

Pentagon's Weapon System Evaluation Group already is weighing Army's anti-missile concept developed by Bell Laboratories against USAF's rival system developed by Convair and Radio Corp. of America (AW May 20, p. 23). Gen. Gavin warned the Senate committee, however, that a proposed $8 million cut in Army's research and development budget for Fiscal 1958 would "damage" fast development of the system. The cut already has passed the House. —**Washington staff**

Fiscal Policy Forcing Airpower Cuts

USAF Secretary Douglas warns 'drastic' slowdown assured if administration holds to fiscal plan.

Washington—Air Force and the aircraft industry apparently are facing the inevitability of stretchouts or elimination of some aircraft and missile programs in Fiscal 1957, Fiscal 1958 and beyond.

Causes behind the tightening on weapon systems are:

- **Administration's strong determination** to stay within budget ceilings and the national debt limit.
- **Defense Department's attempts** to curb partial financing of Air Force programs (AW June 10, p. 33).

Air Force Secretary James H. Douglas predicts "major disruption of the Air Force program" if USAF is not granted some relief and says the two causes listed above will force "major reprogramming and reduction of Fiscal 1958 and prior procurement programs or substantial supplemental appropriation." Douglas has told Defense Secretary Charles E. Wilson:

Forced Shutdowns

"We would need to eliminate some $4 billion of programmed weapon systems in the Fiscal 1958 and prior programs" unless expenditure objectives are adjusted upward.

Later, Brig. Gen. Waymond A. Davis, USAF director of procurement and production, told AVIATION WEEK that if the $4 billion is eliminated there will inevitably be "a closing down of major plants."

Even without such a limitation, Gen. Davis predicted, some private and government facilities will be forced to shutdown. The increased weapon effectiveness, which permits reduction of force structure goals, Davis said, will be "a gradual trend wherein less actual hardware is produced for the same dollar. With less production, competition in industry for Air Force contracts will become keener. Our objective will be to take full advantage of this increased competition and buy our requirements from the supplier who can develop and produce the best product for the least money."

Davis said a detailed study of the effects the elimination of $4 billion from the Fiscal 1958 budget would have on plant shutdowns and the dislocation of manpower will be completed and presented to the Defense Department later this week.

Defense Comptroller W. J. McNeil agreed last week that—unless the administration asks that the national debt limit be increased, and this is considered extremely unlikely—spending at the current rate, with Air Force allowed to continue partial funding, would leave only two alternatives:

- **Termination of certain procurement** programs.
- **Stretchouts of deliveries** of aircraft and missiles over a longer period than is now considered desirable and necessary.

Douglas, McNeil Hold Key

Specific programs affected and the degree to which current contracts will be stretched and planned contracts eliminated must be worked out in detailed negotiations between Douglas and McNeil.

Partial funding of weapons procurement programs will be allowed to continue, most Air Force observers believe—but as the exception rather than the rule and with McNeil having a large part in determining what the exceptions will be.

Regardless of how partial funding is handled, defense spending is running far beyond estimates. If it continued at its present rate, the total for Fiscal 1958 would reach $42 billion—$4 billion over the "firm" $38 billion set by the administration.

McNeil hopes that a normal downward curve, without slowdowns or cutbacks, will keep 1958 spending from reaching $42 billion.

Rising Costs Anticipated

But others—including Air Force—anticipate that rising costs, shorter lead times on weapons, and other factors will cause the spending rate to increase still further and far exceed $42 billion unless stretchout steps are taken.

Douglas estimates that USAF will have to eliminate $3.4 billion in aircraft and related procurement and $800 million in electronics, communications and other non-aircraft procurement to stay within the $17.4 billion expenditure ceiling now set for it.

Navy and Army, which have used the partial funding technique to a far less degree than Air Force, are not strongly affected by the May 21 directive. They are, however, hit hard by the expenditure ceilings and Wilson's memorandum of May 22 which reduced amounts available for obligation in Fiscal 1957 by $100 million for Army, $150 million for Navy and $250 million for Air Force.

Air Force has said it will cut $150 million of that from aircraft and related procurement and $100 million from construction if the order stands.

Army plans to cut $74 million from procurement—which is bound to affect guided missile procurement. Navy has not revealed any breakdown.

Wilson himself has protested to Congress against stretchouts, but he now is in a position of having to tailor the defense program to fit the administration's fiscal plan. He has told Congress:

"The rate of expenditures cannot be cut in any substantial amount unless we delay the modernization and reduce our research and development and possibly reduce some men in uniform. We are facing that."

Wilson added that there were no changes in world conditions to justify reductions in military programs.

Industry's first small indication that Air Force was having trouble with partial financing came last April. Five major airframe manufacturers—Boeing, Lockheed, McDonnell, Convair and Republic—were asked by Air Materiel Command procurement officials to agree formally to a broader use of partial funding.

Industry Dilemma

They discovered that USAF's use of this funding technique was already more widespread than they had realized and had been applied to some fixed price contracts which industry had assumed were fully funded.

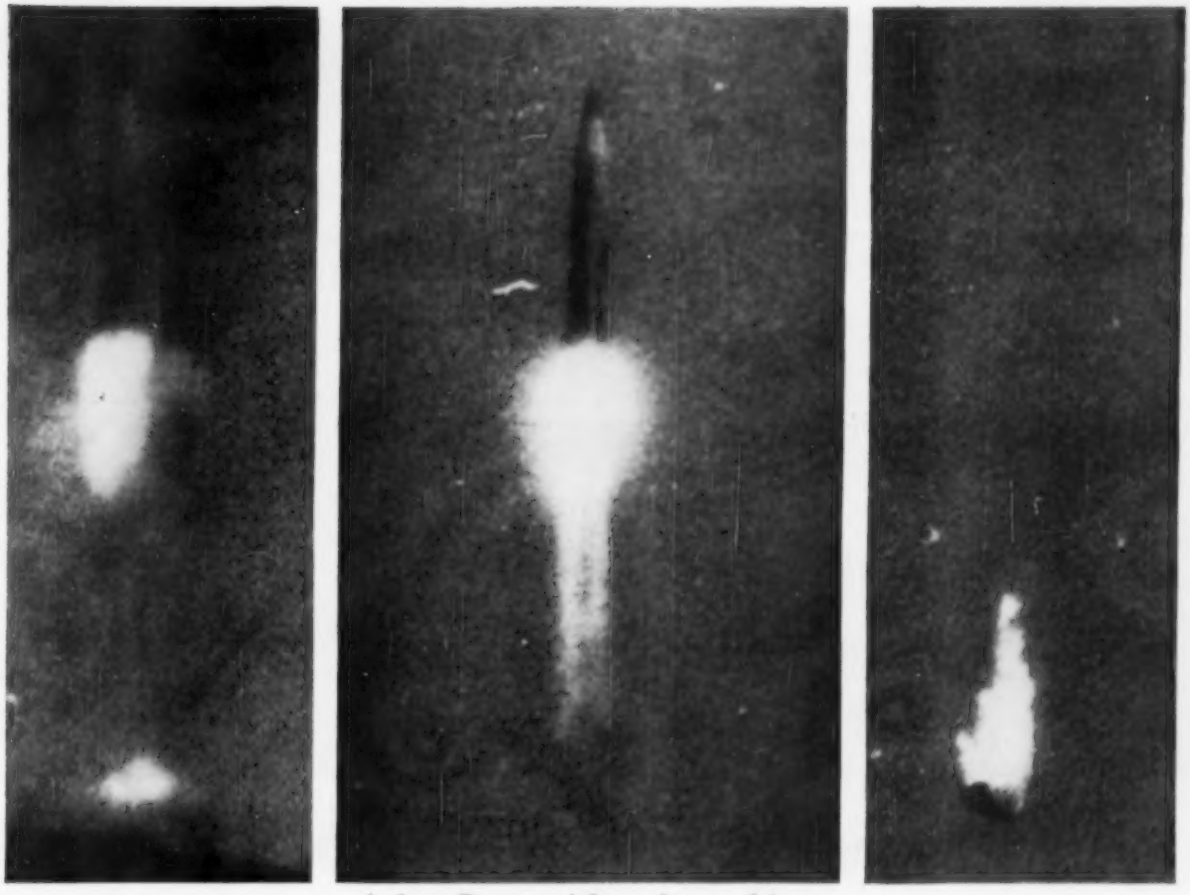
The contract clause which USAF wanted to insert in existing contracts stated that only a specific part of the total price was available and said that "it is anticipated" that additional funds will become available.

It also required "peril-point" reporting—in which a contractor would notify his contracting officer within 30 days of reaching 85% of his first allotment of funds.

If the "anticipated" funds had failed to materialize, termination then was a burden of the Air Force, with the contractor not being considered in default. This was the accession to the contractor for agreeing to a "risk" clause in what was supposed to be a fixed price contract.

Risk comes in because termination is based only on the initial allotment of funds—not on the long-range total program which the contract eventually would have covered. Contractor costs, however, in subcontracts, materials, facilities, personnel, etc., has to be based on total program.

Initial reaction by industry was one of resentment. Companies felt that the increased risks and the increased costs of administration and accounting



Atlas Burns After Launching

Convair's Atlas intercontinental ballistic missile exploded after reaching 5,000 ft. last week in its first test firing from Patrick AFB, Fla. Missile, whose launching was well attended by photographers and other spectators outside the Patrick gates despite USAF's attempt to keep such firings secret, saw the Atlas soar from its launching site, explode and fall into the sea. After the explosion, Air Force said the firing had produced "valuable information" but still declined to identify the missile officially. USAF's first ICBM is powered by a North American 135,000 lb. thrust liquid-propellant engine and two liquid propellant boosters.

necessary under this type of funding had no place in fixed price production contracts.

Aircraft Industries Assn.'s legal and accounting committees and its Board of Governors have been considering the problem.

Not until Wilson's directive of May 22, however, did industry begin to realize how great Air Force's funding problems–due to both the partial funding technique and the expenditure ceilings–had become.

Meetings are being held here this week by a special industry task force to decide how to deal with the problems.

But there is rapidly growing awareness and a slower acceptance of the fact that slowdowns and even some terminations are now a fact of life for the aviation industry.

Repeated warnings over the past several months by Maj. Gen. David H. Baker, director of procurement and production for Air Materiel Command and others–that the impact of maintaining large numbers of superior aircraft while developing extremely expensive missiles was bound to be felt eventually (AW May 27, p. 26)–are now being recalled.

Material for Aviation Week's survey of the Defense Department directive ordering an end to partial financing and its effect upon the aircraft industry was gathered and compiled by Military Editor Evert Clark and Congressional Editor Katherine Johnsen.

Douglas Rebuttal

Douglas, in replying to Wilson's directive and memorandum:

- **Provided a "possible interpretation"** of the partial funding directive and some suggested amendments which he said will "permit the Air Force to proceed with its planned program in accordance with established methods of programming, directing, financing and contracting." These were classified.
- **Pointed out that expenditures** for Fiscal 1957 were running above what had been expected because of the "reduction of aircraft lead time and use of development effort financing methods in the ballistic and other missile programs." Calling this "a hump in expenditures," he asked for reconsideration of the directive and the spending ceilings.
- **Noted that "adjustments** already had been made" in weapon system production schedules for Fiscal 1957 and 1958 before the current arguments over partial funding arose. The Boeing B-52 and KC-135, Lockheed F-104, Republic F-105 and Convair F-106 "as well as some of the missile schedules have been either stretched or adjusted downward," Douglas said.
- **Cited "elimination"** of the Martin B-68 tactical bomber, the advanced fighter/bomber (FBX), and the Douglas C-132–also before the current contro-

versy arose—and said: "As a result of the elimination of the C-132, no new development is included in the program for major transport modernization."

• **Said USAF already has "implemented** a strict control to reduce overtime not only in industry but in the Air Force industrial establishments."

• **Added that contractors' overhead** is being "critically examined . . . with a view toward significantly reducing cost in this area."

While these matters could significantly reduce spending in Fiscal 1958 and later years, Douglas said "there are some items the Air Force may be required to include in the Fiscal 1958 budget procurement program for which no provision has been made." They include:

• **Republic XF-103** and its associated dual cycle engine. Douglas said "strong commitments have been made" but "no (dollar) provision has been made for continuing it."

• **Bell's Rascal air-to-ground missile.** Air Force has decided it is necessary to support the Rascal to "a minimal operational capability," Douglas said.

• **North American Navaho** intercontinental cruise missiles. Navaho "is under active consideration for continuance," Douglas said.

Any decisions to finance those programs in Fiscal '58 would tend to offset reductions made in other areas, Douglas said.

SAC Prepares to Take Control Of Complex of Spanish Bases

By Claude Witze

Madrid, Spain—USAF's Strategic Air Command will take over operational control of the 16th Air Force here on July 1.

With the 16th SAC will get a complex of four new bases serviced by a 485-mile fuel pipeline and seven aircraft control and warning stations. Establishment of the bases and an air defense system for joint use with the Spanish Air Force will open a new frontier against the Russian menace.

The sites in Spain will represent an American investment of $350 million by the end of Fiscal 1958. They will be fully operational by next spring. Several months before that, SAC will start rotating combat aircraft to Spain from stateside bases.

Commander of the 16th will be Maj. Gen. Henry K. Mooney, who will move into headquarters at Torrejon Air Base, 18 miles northeast of this capital. He has been reassigned from March AFB, Calif., where he was deputy commander of the 15th Air Force.

Gen. Mooney will take over from Maj. Gen. August W. Kissner, who is credited with being the man behind the scenes in negotiations that started in 1951 and led to the joint effort to provide Spanish bases for SAC. Gen. Kissner has been in command of both the 16th Air Force and the Joint United States Military Group (JUSMG) in Madrid.

Spain's contribution to the program is that it provides the real estate, all of it on existing Spanish Air Force facilities. U. S. money has been used to build on the real estate. Joint occupancy will provide SAC with new economies in manpower because the bases will be headed by a Spanish Air Force commander. It will be his job to take care of the housekeeping for USAF squadrons and provide local security.

The agreement runs for 10 years with provision for two five-year extensions. If and when USAF leaves, Spain has an option to buy anything not moved out by the retiring tenant. It is clear that what is left will include at least the modern, permanent buildings and vastly improved runway systems now being installed.

The new bases include:

• **Torrejon Air Base,** the Wright Field of the Spanish Air Force, home of its Research and Development Center. The old runway has been overlaid and lengthened to 13,400 ft. A new parking apron, now almost finished, is a mile and a half long, a quarter of a mile wide. It will be the most important air base in Spain, home of SAC's 5th Air Division. In addition to the usual control tower, operations building, alert hangars and refueling system, there will be several shops, 156,000 sq. ft. of warehouse space and quarters for more than 4,500 men.

USAF's estimated investment is $62 million.

• **Zaragoza Air Base,** 200 mi. northeast of Madrid, a merger of two Spanish bases, Sanjurjo and Valenzuela. The combine will have two parallel runways, 10,000 ft. and 12,200 ft. long. One of the fields already has a substantial layout of hangars and warehouses but USAF still is building an underground communications center, control tower, squadron operations building, maintenance shops, quarters for 900 men. More than 46,000 sq. ft. of new warehouses are going up, in addition to a chapel, service club, theater and hospital. Estimated expense: $37 million.

• **Moron Air Base,** 25 mi. southeast of Seville. Here it was necessary for the Spanish to acquire additional land and reroute a highway and railroad. There is a new runway 11,800 ft. long, the usual buildings and maintenance shops, more than 4,500 sq. ft. of warehouse space, recreational facilities and billets for more than 600 men. Estimated cost is $34 million.

• **San Pablo Air Base,** five miles northeast of Seville, future home of the Spain Air Materiel Area (SPAMA). A former municipal airport, the main runway has been increased to 11,500 ft. About ten buildings, including a hospital, are being constructed. U.S. investment here is estimated at $9 million.

Biggest expenditure at a single site will be a $79 million investment at Rota, a port near the southern tip of the peninsula. This will be the first U.S. Naval Air Station in Europe and home of the Sixth Fleet, now based at Villefrance, France, sixty miles northwest of the Straits of Gibraltar. It also will be the home of the Naval Fuel Depot and mouth of the new pipeline serving SAC bases north to Zaragoza, 485 mi. away. U.S. facilities will occupy 5,750 acres with another 160 acres reserved for Spanish use.

Common to all these installations will be the vital lighting, navigation aids, GCA and power facilities. Water supply is difficult to locate and expensive to exploit.

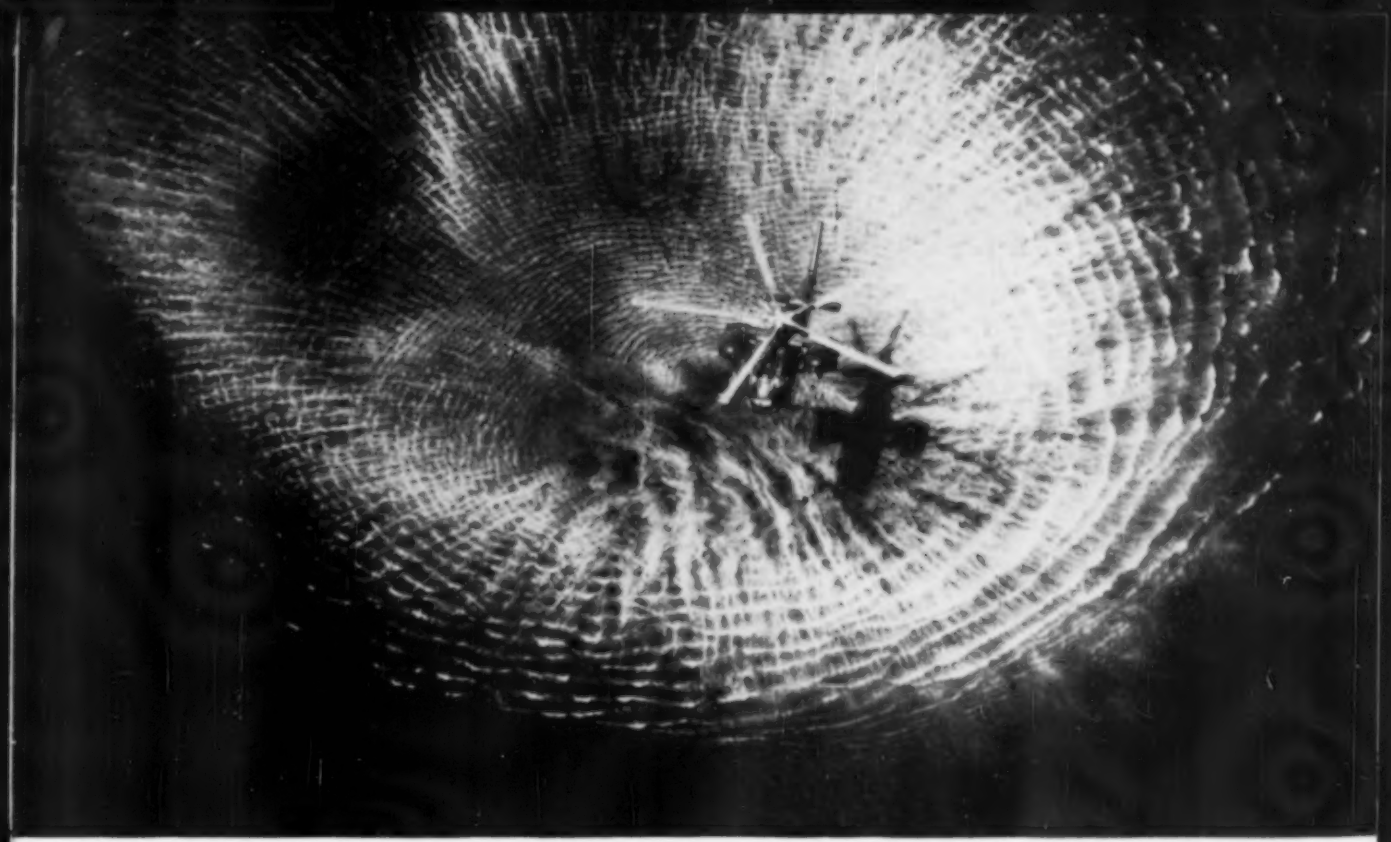
The fuel pipeline is linked to all bases. In addition to Rota, there are major storage areas at Seville, Madrid and Zaragoza.

Total cost of the entire fueling system has been estimated at $41 million.

There is no estimate of how much U.S. is investing in a warning system for the Spanish frontier, but the sites have been identified as Villatobas, Constantinaz, Rosas, Benidorm, Inoges, Goramakil and Soller. Housing is being provided at these points from surplus commodity money.

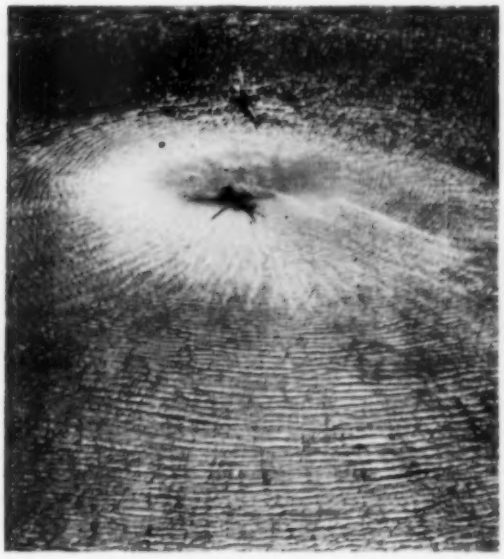
Operation of the air defense network will involve cooperation between U.S. and Spanish units. It will have a network of both heavy and light stations patterned after those developed in the United States and NATO countries. The center will be at Torrejon, from where both U.S. fighter units and North American F-86 Sabres belonging to the Spanish Air Force will be controlled.

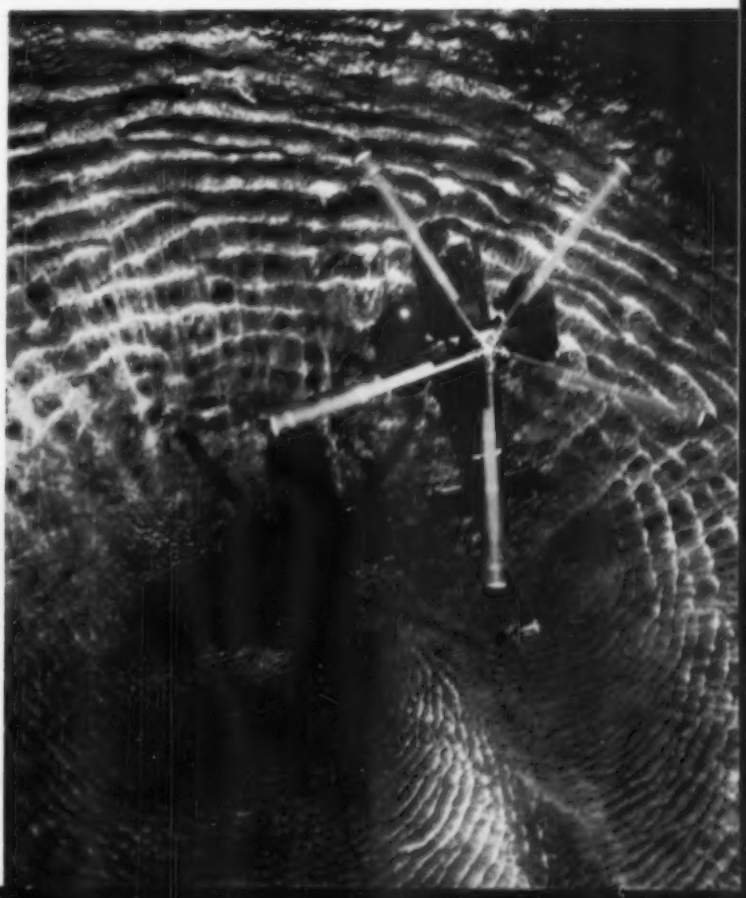
Gen. Kissner emphasizes there has been no crash program to rush construction in Spain. The prime contractor is a joint firm formed for the job under the name of Brown, Raymond and Walsh. It is composed of Brown & Root of Houston, Tex.; Raymond Concrete Pile Co. of New York and the Walsh Construction Co. of Davenport, Iowa.



S-56 Rotor Downwash Draws Patterns

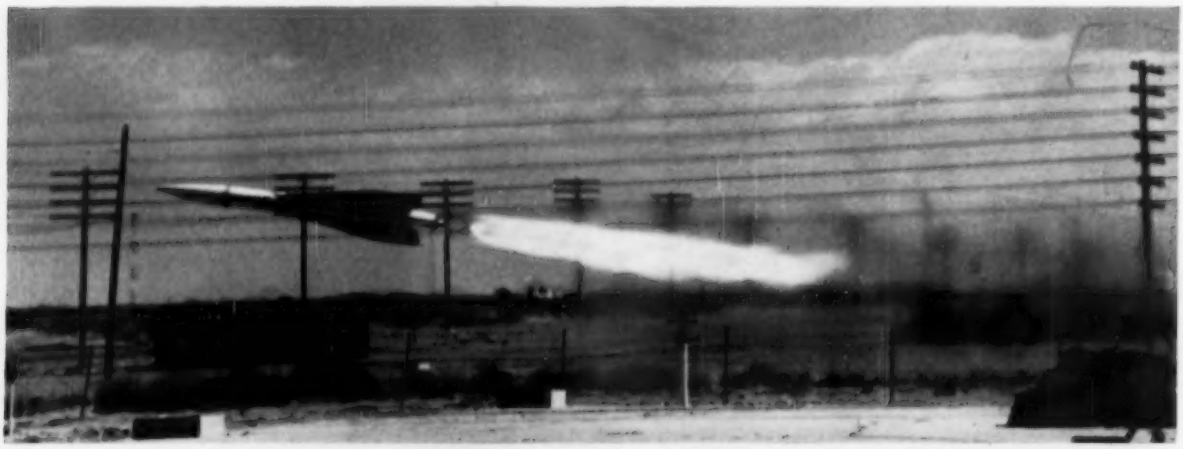
Downwash from five bladed rotor of Sikorsky S-56 helicopter on a flight test from company plant at Stratford, Conn., etches varying pattern on water of Long Island Sound. Hovering by the twin engine helicopter over water has no significance in test program, but has aesthetic value to photographer.





Hawk Defends at Low Altitudes

Army's new air defense missile, the Raytheon Hawk, is designed to complement Nike system by providing capability to destroy low altitude attackers. Missile is 16 ft. long, 14 inches in diameter, uses solid propellant. Radar guidance system of missile detects and tracks aircraft at altitude in blind spots of conventional radar. Ground radar tower is visible in firing shot. Films shown in Washington last week revealed that Hawk was able to discriminate between several drones and pick out the one designated as its target. Research and development missiles now are being produced for Army Ordnance at Raytheon's Andover, Mass., plant, and pilot production will begin there soon. Northrop Aircraft is subcontractor for the airframe. Army now is selecting sites in the New York and Washington-Baltimore areas. Though positioning of site is comparatively rigid, only an absolute minimum of land is to be acquired to emplace, operate and administer the weapon. About 40 acres will be needed, using underground storage to hold down space requirements. Safety considerations also play a role in use of underground storage.



Hawk, here launched at low deflection, displays delta wings of very short span and large root chord. Leading edge sweep approaches 80 deg., and tips are truncated. Description compares closely with that disclosed by Aviation Week (Dec. 10, p. 23) and in exclusive photographs of USAF bomber defense missile test vehicle based on Hawk (AW Jan. 21, p. 34). Cornell Aeronautical Laboratory is systems engineering manager for the Air Force BDM system. Warhead of Hawk can be nuclear or conventional. Range of the weapon has been estimated at approximately 22 mi., which would compare favorably to that of the Nike Ajax. Improved Nike Hercules will have range two to three times as great.

Navy Views Polaris As Support Weapon

San Francisco—Navy's fleet ballistic missile Polaris will be a supporting weapon in future task forces which will still be built around the aircraft carrier, Rear Adm. W. F. Raborn told members of the American Rocket Society and the American Society of Mechanical Engineers. Raborn is director of the Polaris project.

Development of the Polaris does not mean that Navy has abandoned the concept of balanced forces using a combination of weapons, he said. Its tactical mission would be to beat down fixed base air and missile defense to pave the way for carrier strikes aimed at destroying mobile or concealed primary targets.

Need for precise knowledge of the locations of launcher and target makes the ballistic missile relatively useless against the concealed targets.

The air-breathing cruise missile does have a part to play in the balanced force concept because it is comparatively easy to design a terminal guidance system that will direct it to approximately located targets.

Infantry Comparison

Raborn compared manned carrier aircraft to infantry. He said enemy military operations cannot be halted until the manned airplane is on the scene to cope with targets beyond the sophistication of missile guidance systems now anticipated.

Raborn claimed the seaborne ballistic missile would be more difficult to counter with an anti-missile defense than its land-based cousin. Infinite number of launching points available will make it impossible to pre-plot the trajectory of Polaris, he said.

Technical sessions of the two professional societies attracted about 1,800 people.

Ramjets received much attention from Rocket Society authors. Methods and equipment for experimentally determining ramjet dynamic characteristics were outlined by Carl B. Wentworth and George Vasu of NACA's Lewis Flight Propulsion Laboratory.

They pointed out that the dynamic behavior of ramjets can best be studied by operating them in the realistic environments of wind tunnels and free jets.

Since thrust is dependent on internal pressures, interest is centered on transient behavior of engine pressures in an unsteady environment.

Pressure at the combustor inlet is a function of combustor temperature ratio and reaches its maximum when the diffuser normal shock is at the lip of the diffuser inlet. This set of circumstances suggests that operation can be controlled by varying fuel-air ratio to establish the right temperature ratio. To do this, shock position must be sensed by the fuel control systems and the sensing of unforeseen disturbances is an important problem for the designer.

A wind tunnel or free jet to be used in studying the problem must be capable of simulating the supercritical regime in which too low a temperature ratio allows the diffuser to swallow the shock, and the subcritical regime in which too high a ratio pushes the shock out of the inlet. The subcritical region is the more difficult to obtain in the laboratory.

Facility Size

Pressure disturbances are propagated through the air stream at the speed of sound which varies with the square root of temperature. Therefore, correct simulation demands that the stagnation temperature of engine air in the tunnel must be the same as that for the engine in flight.

Present analytical tools are incapable of deriving full scale engine dynamics from scale model tests so a facility to be useful must be able to accommodate the actual engine.

The supersonic wind tunnel provides good simulation of Mach numbers and pressures inside and outside the engine, can be operated in the subcritical regime and may be roomy enough to permit angle of attack changes. Few existing closed circuit tunnels can be used to test a running engine because temperatures are raised and air is contaminated by exhaust. In open circuit tunnels, pressure altitude is a function of Mach number and cannot be varied independently. The temperature of tunnel air is limited by the response of tunnel wall materials to temperature and stress.

Because of the necessary stagnation temperature errors in existing tunnels, the speed of pressure disturbance propagation may be about 25% less than that in flight at high Mach numbers and high altitudes.

The free jet is a type of facility which has been used with engines as large as 48 in. in diameter. If the diameter of the stream is large enough compared to the inlet it is possible to simulate both subcritical and supercritical operation.

Because the supersonic nozzle has a fixed configuration, there are no highly stressed walls as in wind tunnels to limit air temperatures. Tests were reported in which no trouble was reported at temperatures over 900F. Since nozzle shape is fixed, the nozzles must be replaced to change the test Mach number.

Raymond Greenberg of Curtiss-Wright described the Phase IV ramjet test facility at the company's Wood-Ridge, N. J. plant. It is a blow down tunnel using high pressure stored air coupled with low pressure air from continuously operated compressors. Heaters raise the air temperature to the desired level. Pressure altitude is varied by exhausting air through a series of steam fed ejectors.

The system can be run intermittently for simulation of altitudes around 45,000 ft. on the stored air or continuously from the compressors which permit higher altitude simulation. Two chambers can be supplied through insulated ducts and surge tanks.

One test chamber is 12 ft. in diameter and 60 ft. long. Its surge tank is removable to permit mounting of the engine. The other is 14 ft. in diameter, 90 ft. long and has a side hatch for engine mounting. Pressure leakage is prevented by hydraulic locks and water inflated seals.

The facility is capable of three modes of testing: direct connect, ducted nozzle and free jet. The free jet has been found especially valuable in studying buzz cycle and control system performance margins.

Heating Simulation

The combination of the high pressure blow down system and the low pressure compressor system enables the operator to simulate starting at low altitudes and climb to high altitudes during which the blow down system is shut down and the compressor continues to run.

During simultaneous operation, air from the two sources is mixed by an air-to-air ejector.

High fuel temperatures due to aerodynamic heating are simulated by running fuel through steam heat exchangers. Three-way control valves bypass and mix fuel in varying proportions to program temperature changes. Maximum temperature is 350F. An additional chemical heat exchanger can be used to raise fuel temperature to 500F.

Method of flame stabilization in the boundary layer of a heated plate was presented by Richard W. Ziemer of Armour Research Foundation and Ali Bulent Cambel of Northwestern University. It has obvious applications in ramjets and afterburners to replace bluff bodied flame-holders which interfere with flow and create turbulence. In practice, the heated surface may be a circular cylinder or a flat plate aligned parallel to the flow. Flow separation does not occur with boundary layer

flame stabilization and no turbulence is generated.

Since boundary layer velocity decreases as the surface is approached, there is a line along which stream velocity and flame propagation velocity are equal. In the area behind this line where stream velocity is less than flame propagation velocity, the flame front will move upstream to the locus of equal velocities and advance along it to the upstream position where the boundary layer is so thin as to quench the flame.

The plate absorbs some heat from the burning mixture and in so doing quenches the flame in the part of boundary layer closest to it. The depth of this dead space determines how far upstream the flame can be stabilized. A cold plate would let the flame be blown out of the engine.

The intersection of the upper edge of the dead space and the locus of equal velocities represents the point of furthest advance. The flame front should stabilize here and propagate into the fresh mixture.

When the surface temperature is raised, three important changes take place which stabilize the flame:

• **Flame propagation velocity** rises where local fuel-air charge temperatures are higher.

• **Boundary layer thickness** increases with increased heat transfer from the surface.

• **Dead space thickness** decreases when higher surface temperature cuts the amount of heat lost through the wall.

Turbulence in the approaching mixture would increase flame propagation rate but the rapid flame spreading associated with bluff bodied flame holders does not ordinarily occur with boundary layer stabilization.

Three areas of progress in the study of hypersonic flow during the past two years were cited by Lester Lees of the Guggenheim Aeronautical Laboratory at California Institute of Technology:

• **Blunt-body** aerodynamics and heat transfer.

• **Aerodynamics** of blunt-nose slender bodies, including various viscous interactions.

• **Real gas effects.** In this field, thorough studies have been made of radiation from hot gases in the shock layer around a blunt body and electrical conductivity of air at high temperatures. Lower limits have been found for chemical dissociation rates across shock waves and for recombination rates in rapidly cooled flows.

Vibrational relaxation times of oxygen, nitrogen, carbon dioxide and carbon monoxide at high temperatures have been learned.

New Alloys Can Avoid Weight Rise

San Francisco—Currently available heat-resistant materials will impose serious weight penalty on the high performance supersonic aircraft, but promising high strength experimental titanium or other alloys in development can make the hot airplane competitive in gross weight with present aluminum alloy airplanes.

This was the gist of what two Lockheed Aircraft Corp. engineers, H. B. Sipple, a materials and process engineer, and G. G. Walk, a research specialist, told a meeting here of the American Society of Mechanical Engineers. The Society held joint sessions with the American Rocket Society.

Size of Penalty

For 600F operation, the Lockheed engineers pointed out, an airplane using currently available high temperature materials can be expected to weigh 1½ times as much as its predecessor counterpart in aluminum alloy. Other points about the hot airplane the Lockheed men brought out:

• **Completely new** manufacturing methods will be required. To make the transition on schedule, and at least expense, it is essential that the high-strength heat-resistant materials be developed where possible for use within limits of existing fabricating equipment. Nevertheless, innovations probably will be required in forming and machining, and weldability of new materials will have to be evaluated.

• **Larger sizes,** close tolerances, and dimensional precision needs will be more critical in most cases in the heat-resistant materials because of the relatively greater weight penalty involved for excess material.

• **Non-metallic materials** pose critical development problems. Plastics for transparent enclosures and radomes, elastomers for fuel and oil sealants, tires and flexible fuel cells, and polymers for paints and insulating materials pose formidable development needs.

Use of die steels in new high-speed aircraft was emphasized by E. A. Simkovich of Republic Aviation Corp.'s engineering research section. Pointing out that current titanium sheet and bar alloys cannot be utilized efficiently at 650-1,000F, Simkovich said the so-called "hot-work die steels" had been introduced. These materials temper at about 1,050F, are quite stable and have good fabrication characteristics, he declared.

"Our two years of experience with the die steels leads us to believe that in the majority of applications in 650-1,000F, they are far superior to any of the known available alloys," Simkovich said.

Potential High

These steels have a tremendous potential, Simkovich said, not only for applications involving extreme temperature, but also for use at low temperature. Landing gear axles of Republic's new fighter-bombers are made from 5CR-MO-V die steel, and work is under way to replace more of the low-temperature steels with a die grade.

One of the problems involved in die steels is need for care in heat treatment. Decarburization is quite rapid at temperatures involved, so that salt baths or inert atmospheres must be used.

One of the more promising new fabrication methods which permits optimum structural use of a material is flashwelding, Simkovich said. While landing gears have used this method quite extensively, very little attention has been given to the process for major structural parts, he added. Republic plans to use the process in manufacture of very large structures, such as wing spars, and testing of components is under way. One recent application is a dive brake attachment flashwelded from two 4MN-4AL titanium forgings. Evaluation has indicated excellent tensile, bend, creep, and fatigue properties for the weldment.

Engine Analyzer

Need for an engine analyzer in connection with turbojet powerplants installed in aircraft was stressed by L. A. Wilson, Navy Bureau of Aeronautics powerplant maintenance engineering technician.

One of the greatest maintenance problems is detection and correction of malfunctioning in installed jet engines, he said. To cope with this difficulty, the analyzer should be able to indicate if the engine is operating correctly and, if not, locate the trouble source. Ideal analyzer, he said, would be sufficiently small in size and weight for installation in an aircraft. But even a larger instrument would be suitable, he added, providing it would be portable, for use in ground checks during routine maintenance.

The analyzer would be most useful in detecting malfunctioning before failure occurs and in distinguishing

Coverage of the American Rocket Society and American Society of Mechanical Engineers sessions in San Francisco was provided by Irving Stone and Russell Hawkes of Aviation Week's Los Angeles Bureau.

Petrel Shows Size

Size of Fairchild Petrel air-to-underwater missile is underscored by new picture of weapons now out of production. Missile is 24 ft. long and has span of 13 ft., diameter of 2 ft. It is powered by Fairchild J44 turbojet engine, uses radar homing for guidance. Missile is mounted on Lockheed P2V Neptune, which can carry one Petrel under each wing.

between troubles requiring an engine overhaul and those requiring replacement of an accessory.

In addition to vibration analysis, the analyzer should provide the line mechanic with answers to these questions:

- **Is engine developing** enough thrust to give expected performance?
- **Is specific fuel** consumption such that plane can perform its normal mission?
- **Will plane operate** throughout range of speed and altitude without encountering slow acceleration, compressor stall, over-temperature, hot spots and flameouts?
- **If malfunctions** are revealed, what accessory or component is cause?

Safety in Design

Highlights of industry's focus on safety in design detail were presented by Jerome Lederer, director, Flight Safety Foundation, Inc. Emphasizing the importance of human factors to design safety, Lederer related that Lockheed's Marietta, Ga., Human Engineering Group had surveyed about 40 major aircraft and equipment manufacturers to determine state of human factors research programs in these companies. Survey revealed:

- **Human factors research** program had been organized by 24 of the companies, six others were organizing such groups, and one was using a consultant for this purpose.
- **Most of the human** factors groups report to high levels in the engineering division. About half of the groups participate in design as well as in applied experimentation.
- **Size of groups** ranges from one to 32, six being the average, with an anticipated growth in almost all companies.
- **Specialities of members** are about equally divided between psychologists and engineers, with smaller numbers of physiologists, aeromedical specialists, pilots, operation analysts, etc. Total of 207 professional and technical people were employed in reported programs.

Convair Division of General Dynamics Corp., Boeing Airplane Co., and Republic Aviation Corp. are making significant contributions through design safety groups which monitor design to insure that previous mistakes are not repeated, Lederer told AVIATION WEEK.

In Convair's Fort Worth plant, Design Safety Section gets information from CAA, USAF, Navy, NACA, airlines, foundations, field service and other Convair facilities, feeds this data to groups encompassing a broad area of activity under airframe and system design, flight and ground operation, and human factors. Thus, under human factors, there are study divisions for escape systems, air contamination, controls and instrument arrangement environment limitations, nuclear hazards, crash survival and space flight.

Key factor in missile auxiliary power-supply development were outlined by W. R. Chapman, development manager, and T. C. Noonan, associate director, Staff Research and Development, Thompson Products, Inc.

Approach to Problem

Approach used to overcome problem involved in various phases associated with perfecting a system includes these highlights:

- **Accomplish early research** and development on systems and principal hardware to anticipated requirements. This must be done by advanced financing from one to two years prior to a formalized customer specification.
- **Supplier-manufacturer and customer** must continually coordinate closely requirements for the whole system so that it eventually matches "the most subtle needs" of the missile. There must be an integration of power systems and missile subsystems to form a complete system which can operate as desired when all subsystems interplay during the missile flight.
- **Institute backup programs** on components and in critical areas. In one

program, backup effort on components was utilized in more than half of the total major components, Chapman and Noonan revealed. Backup procedure is extremely expensive from initial development standpoint, but doubles assurance of ultimate success and cuts development time.

• **Separate research** and development phase from production of large numbers of experimental models or prototypes, by providing separate shop, assembly and test facilities.

An advanced auxiliary power system requires 3-5 years from beginning of applied research and feasibility study to delivery of first production unit. This means that the supplier-manufacturer should have available for planning and research the 5-10 year anticipated future system requirements, Chapman and Noonan said.

Some avenues for future investigation for improvement include:

• **Research on elastomers** for seal and fuel-expulsion-system application with commonly used monopropellants.

• **Evaluation of monopropellant** characteristics related to safety, long-term storage and solid deposition during decomposition.

• **Research** on all types of turbines to obtain performance characteristics and criteria for use by turbine designer.

• **Comparative study** of performance, weight and reliability of principal auxiliary power techniques versus horsepower and duration for future applications.

• **Studies of bearings** and lubrication in ultra-highspeed rotating machinery at expected temperature extremes.

• **Investigation of hot gas** static and rotating seals for improved reliability and ease in assembly and servicing.

X-7 Test Program Will Be Continued

Sunnyvale, Calif.—Lockheed Missile Systems will continue its ramjet engine flight test program under a $14.5 million USAF contract.

This means continued service for the Lockheed X-7 ramjet test vehicle. The new contract, one of the largest received in the 10 year history of the X-7, will extend the X-7 program through mid-1958.

Sea Slug Will Go on Four New Destroyers

London—Armstrong Whitworth Sea Slug ship-to-air guided missile will be fitted to the four guided weapons destroyers now on order for the Admiralty.

Sea Slug is described as a medium range weapon. Its propulsion system consists of a sustainer motor and four boosters which are jettisoned after the missile reaches supersonic speed. Sea Slug can be operated and fired without exposing any of the ship's personnel to danger, the Admiralty says. The missiles are fired from a triple ramp launcher which is fed automatically from a magazine below decks.

Tests of Sea Slug have been carried out on the Clausen rolling platform at the Aberporth Missile Range and aboard the guided weapon trials ship H.M.S. Girdle Ness. Of the firings at sea from the Girdle Ness, the "vast majority" have been successful, the Navy reports.

Sea Slug is 19-ft, 6-in. long, 20 in. in diameter and has a 63 in. wingspan.

Firms associated with the development of the Sea Slug weapon system include General Electric Co., Sperry Gyro Co., John Thompson Conveyor Co., Sir Geo. Godfrey and partners, Vickers Armstrongs, Metropolitan Vickers, McMichael Radio, E.M.I. Engineering Development, and Imperial Chemical Industries.

CF-100 Breaks Up, Crashes

Disintegrating Avro CF-100 has just lost wing tips and tail before spectators at an air show at London, Ont. Two man Royal Canadian Air Force crew was killed in crash. Interceptor, approaching airport at high speed and low altitude, began to break up shortly after pilot started slight pull out. Wing tips broke upwards first and tail followed. The aircraft went into a flat spin, shedding structure, crashed and burned. Crowd escaped injury.

Victor, Vulcan Pass Mach 1, British Say

London—Britain's Vulcan and Victor V-bombers, which are appearing in two new versions, have passed Mach 1 during flight tests. The transitions occurred in dives, and in the case of the Handley Page Victor, occurred accidentally.

Handley Page asserts that the Victor is the "largest airplane in the world to break the sound barrier." It has a wing span of 110 ft. and a length of nearly 115 ft.

The company asserted that Mach 1 was exceeded when the pilot's attention was diverted elsewhere during a high speed run.

This led to an unintentionally amusing headline in the Times: "Victor bomber faster than sound—an inadvertent success."

Handley Page's announcement of the event was quickly followed by a claim from A. V. Roe that its Vulcan had exceeded the speed of sound on "several occasions."

New version of the Vulcan, the Mk. II, will use the Bristol Olympus Mk. 6 turbojet engine rated at 16,000 lb. thrust. The Victor Mk. II will use Rolls-Royce Conway Mk. II engines.

Choice of the Bristol engine for the Vulcan indicates British have decided against complete Rolls-Royce domination of the British jet engine market.

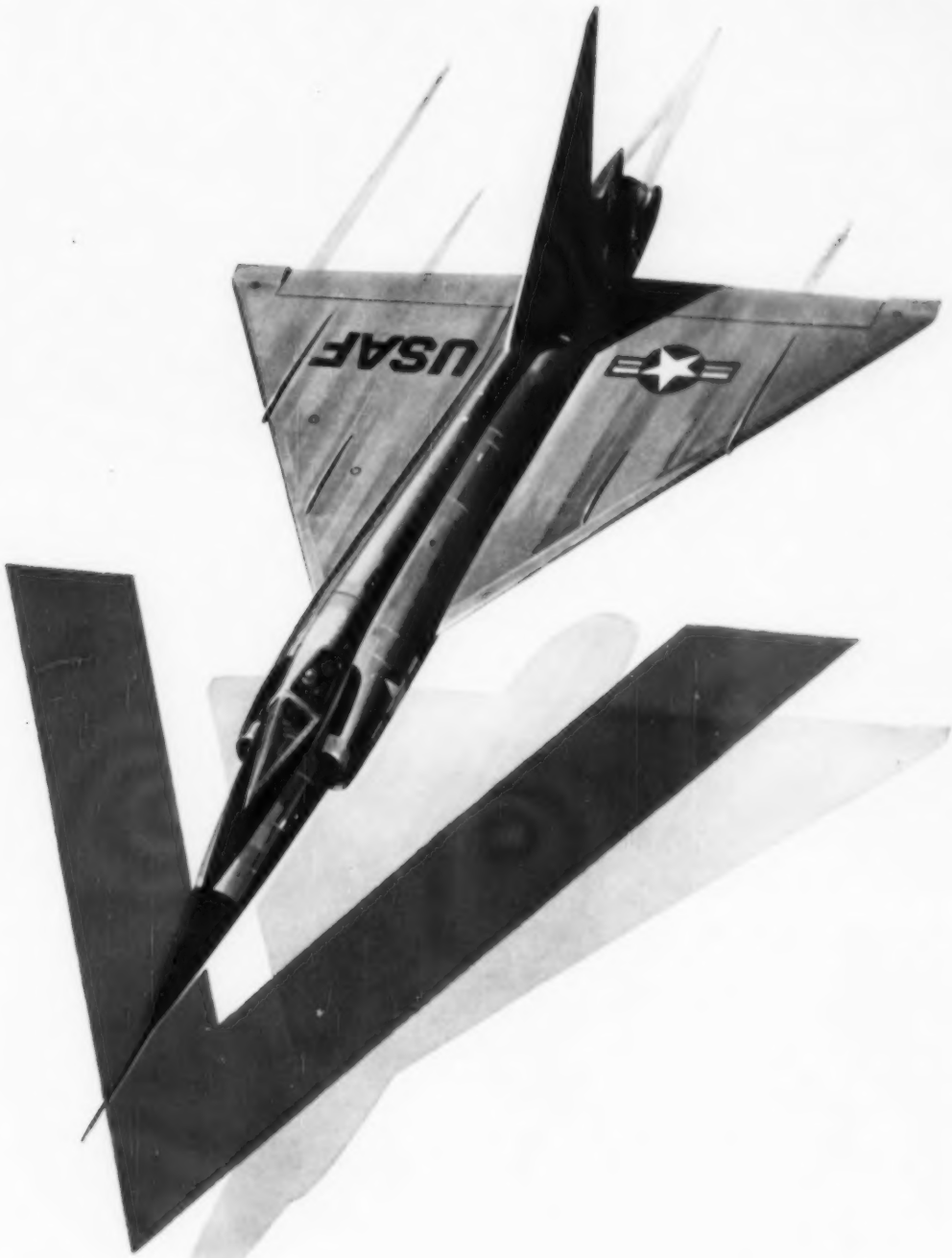
News Digest

Convair B-58 detachable pod drop tests began at ARDC's Special Weapons Center, Kirtland AFB, N. Mex.

Titanium sponge price reductions will save fabricators 50 cents a pound. Du Pont Co., reduced its Grade A-1 from $2.75 to $2.25; Grade A-2 from $2.50 to $2 and Grade A-2 fines from $2.15 to $1.65 a pound. Titanium Metals Corp., which has one grade corresponding to du Pont A-1, reduced price from $2.75 to $2.25. Reductions followed cuts made previously on bar and billet.

Lear, Inc., will build three axis damping systems for Lockheed F-104. Stockholders also were told at annual meeting that Lear is building flight reference and automatic flight control systems for helicopters and Northrop T-38 trainer.

Continental Motors, which earned $705,699 in the first half of 1956 fiscal year, almost tripled that figure this year. First six months earnings, for period ending April 30, were $2,007,067.



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SIKORSKY H-34 ARMY HELICOPTER
World's Speed Record for 100, 500 and 1000 Kilometers, July 12, 1956

The two craft shown here use Vickers pumps, motors and valves for a variety of important operations.

• • • • • • •

New and unusual applications for hydraulics are being scheduled into several of the newer helicopter designs. Among these are hydraulic motor operated fuel transfer pumps and hose reels. Vickers Hydraulic Equipment will also be used for taxiing, rotor fold, starting, rescue hoist systems and auxiliary electrical power generation.

• • • • • • •

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ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

F3H, F8U Probes

Refueling probe on McDonnell F3H Demon (right) and Chance Vought F8U Crusader (above and below) is a retractable unit near cockpit. F8U system is covered by door when not in use. Demon installation was on planes of Carrier Group 8 which were displayed at Andrews AFB for Armed Forces Day. Tanker for Crusader is North American AJ Savage. Probe on earlier Navy airplanes, F9F for example, was mounted in nose like a test boom in what seemed to be cleaner though more remote installation.

Delta Buckles Down to Jet Planning

Traffic, fleet analyzed by management consultants to give carrier picture of future maintenance need.

By Glenn Garrison

New York—One airline's solution to a jet planning problem has been to hire a consultant to take a long, deep look into the fast-approaching future and spell out just what facilities will be needed to maintain the new generation of aircraft and phase out the old.

In a massive report recently handed to Delta Air Lines by the management consultant firm of Cresap, McCormick and Paget, Delta's traffic and fleet situation through 1975 is analyzed and the following major recommendations made:

- **Jet and piston** aircraft and engine overhaul facilities should be combined and located in a single new unit to be built at a specified city.
- **Four-engined** A, B and C check facilities should be separated from the overhaul base and located at another specified city.

Purpose of the study, which required seven months and considerable work with Delta, other airlines, airframe and engine manufacturers, engine overhaul contractors, military and other government agencies, was to determine the additional maintenance and overhaul facilities Delta would need for the jets it expects to receive within the next five years, and the layout and location of these facilities.

Five areas were explored in the study:

- **Requirement for all equipment, manpower** and parts for overhaul and maintenance of jet airplanes to be acquired by Delta between now and 1960, to meet traffic volume through 1965.
- **Location of jet** overhaul and maintenance facilities providing maximum service at lowest cost.
- **Present piston facilities** which might be combined with jet facilities.
- **Layout and manpower** requirements for the facilities.
- **Economic and operating** considerations applicable to different possible facility locations.

Cresap, McCormick and Paget set up a detailed schedule for Delta to follow in developing jet facilities and training personnel, and urged the airline to create a separate planning unit fully responsible for the jet program.

Stressing the importance of proper immediate planning for the advent of jets, CMP's report predicts that those airlines which do the soundest job of forward planning will be the ones most likely to survive.

"It has been the experience of Cresap, McCormick and Paget," Delta is informed in the report, "that, as a business grows in size, at different stages of growth different organizational problems will arise. Also, most industries go through a stage of industry-wide growth, when the creation of excess capacity and the problems confronting management in adjusting to these changing conditions result in a period of declining profits and the failure of those in the industry least able to compete."

The airline industry may go through such a period during the next ten years, according to CMP, and "because of the great demands for outside capital to finance the great expansion anticipated, all airlines are and will be in a particularly vulnerable position." During the course of the study, the firm reports, jet programs of other major airlines, including American, TWA, Eastern and Pan American were examined closely. Each of these airlines has a separate jet planning facility.

Comprehensive Plan

From these survey contacts, the report notes, "it seems clear that Delta's planning for the jet age is at present as complete and comprehensive as that of any of the major airlines.

But unless Delta sets up the recommended staff planning unit, "this advantage will certainly be lost."

Following out this recommendation, Delta has added a facilities planning group to its already existing facilities construction group. The airline also has appointed a coordinator for its jet maintenance program and has added about half a dozen people from various technical departments to the work.

"We have had people doing this job anyhow," Charles H. Dolson, vice president-operations, told AVIATION WEEK, "but they were spread pretty thin."

Dolson left doubts as to whether the CMP report's major recommendations will be carried out on schedule. A big question mark is money.

Delta accepts the report as a long-range proposition, Dolson said, but is taking a further look at cost estimates. Also, the airline is still considering farming out its jet overhaul for the first couple of years, a move that the report does not recommend for Delta.

But the study pointed up the need for detailed planning, which Delta people are now doing, Dolson noted.

New Field

When CMP took on the jet maintenance planning assignment for Delta, it entered an area in which there was little commercial experience as guidance. During the first phase of the study, the consultants found no accurate information available on commercial jet aircraft or engine performance, although "considerable information can be expected to become available within the next two or three years."

Slowness with which airlines have come to grips with their jet planning problems until recently is illustrated, CMP partner Harry G. Beggs told AVIATION WEEK, by the fact that several airlines have hurriedly changed their minds in recent months about locations for jet maintenance bases.

His firm's first step in beginning the study, Beggs said, was to spend about a month in digging out and checking various traffic forecasts to provide an estimate of workload Delta can expect in terms of aircraft flying hours.

Starting with Dec. 31, 1960, as a point at which Delta's DC-8s and Convair 880s will all be in service, a forecast of flying hours of the various aircraft in expected configurations was made on an annual basis through 1975.

The projections were drawn from Delta estimates for its own routes and applied against several other overall forecasts. Some of the highlights of the estimates:

- **Delta will handle** a volume of 3,978 million passenger-miles in 1965 with a 62.5% load factor and revenues of $245,221,200. Totals assume a 25% annual increase for new routes.
- **Shortage of 945 million** seat-miles per year will exist as of Aug. 31, 1959, just prior to delivery of first jet transports.
- **Surplus of 1,230 million** available seat-miles will occur in late 1960 after the start of jet operations. Excess represents capacities of 14 DC-3s, seven DC-6s and 12 DC-7s.
- **Long-range and short-range** service will remain a constant 65% and 35%, respectively, of total revenue passenger-miles through 1975.
- **DC-8s will provide** long-range coach

DIRECT MAINTENANCE MAN-HOURS 1959 TO 1975		AUGUST 1959	SEPTEMBER 1959	APRIL 1960	NOVEMBER 1960	DECEMBER 1960	DECEMBER 1961	DECEMBER 1962	DECEMBER 1963	DECEMBER 1965	DECEMBER 1975
A, B And C Checks Man-Hours	CV-880	-	-	15,876	173,826	167,265	141,669	137,295	115,400	124,535	255,150
	DC-8	-	56,448	106,987	112,412	113,434	113,129	117,376	101,696	120,960	246,400
	Turbo-Prop	-	-	-	-	-	-	68,000	115,614	189,295	300,560
	DC-7	204,901	151,436	131,784	46,818	52,887	66,181	30,923	2,890	-	-
	DC-6 or 6A	34,884	35,112	16,444	-	8,892	9,804	10,260	10,944	-	-
	CV-440	150,876	152,460	143,550	120,186	120,186	120,186	120,186	119,196	-	-
	TOTAL	390,661	395,456	414,841	453,242	462,664	450,969	484,100	463,740	434,590	802,110
Operational Check Man-Hours	CV-880	-	-	55,667	379,658	370,339	282,163	248,496	240,480	224,448	464,928
	DC-8	-	114,420	230,293	239,786	233,938	217,663	205,424	205,424	211,900	425,800
	Turbo-Prop	-	-	-	-	-	-	199,908	319,329	526,432	682,680
	DC-7	395,120	287,360	251,440	86,208	100,576	129,312	57,472	7,184	-	-
	DC-6 or 6A	142,008	142,008	71,004	-	35,502	35,502	47,336	47,336	-	-
	CV-440	308,629	308,629	292,936	245,857	245,857	245,857	245,857	240,626	-	-
	TOTAL	845,757	852,423	879,340	951,489	986,212	910,497	996,553	1,058,379	980,780	1,571,208
Engine Overhaul Man-Hours	CV-880	-	-	148,160	811,345	566,456	442,976	359,645	299,462	216,307	518,631
	DC-8	-	376,580	402,851	365,772	372,944	310,010	267,874	236,228	189,609	287,776
	Turbo-Prop	-	-	-	-	-	-	466,525	313,352	421,237	518,563
	DC-7	592,644	435,968	381,472	136,240	121,254	143,052	66,417	6,386	-	-
	DC-6 or 6A	78,988	72,912	36,456	-	19,747	20,203	20,507	20,658	-	-
	CV-440	149,296	149,296	142,072	117,992	117,992	112,092	106,193	99,270	-	-
	TOTAL	820,928	1,034,706	1,101,011	1,431,349	1,198,393	1,028,333	1,288,359	975,356	827,154	1,324,970
	GRAND TOTAL	2,057,346	2,282,585	2,395,192	2,836,080	2,647,269	2,389,799	2,769,012	2,497,475	2,242,524	3,498,288

service, while long-range first class service will be provided by the 880s. Initially, the DC-8s may be operated combination, with 70 coach and 50 first class seats, but the aircraft will be fully coach by Dec. 31, 1960.

• **Coach service in** long-range aircraft will increase to 35% of total passenger miles in 1960, 45% in 1965 and remain at 45% thereafter, while long-range first class will decline to 20% by 1965 and remain at that level.

• **By 1965,** all piston passenger aircraft will be replaced by turboprops of the Electra type, which will provide all short-range coach and first class capacity. Turboprops also will replace DC-6As in all-cargo service by 1965.

Breakdown of flying hours by Delta indicates this picture in 1960:

Type:	Class	Flying Hr. Per Year
CV-880	First	32,820
DC-8	Coach	23,356
CV-440	First	81,760
DC-7	First	17,015
DC-7	Coach	7,549
DC-6A	Freighter	5,288

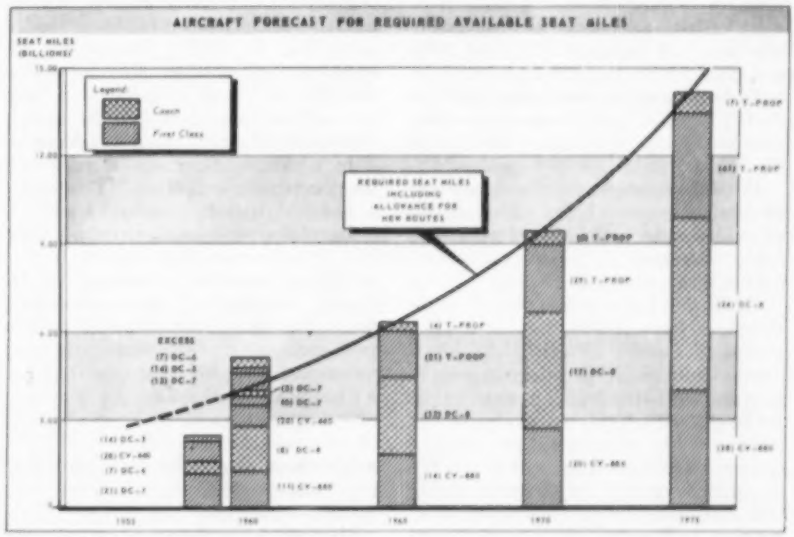
By 1975, this picture is expected:

Type:	Class	Flying Hr. Per Year
CV-880	First	85,947
DC-8	Coach	74,878
Turboprop	First	118,100
Turboprop	Coach	18,371
Turboprop	Freighter	5,327

Next in the study was a second critical forecast—the check and overhaul intervals for jet aircraft and engines.

Cresap, McCormick and Paget ob-

PREDICTED manhours for maintenance (above) show A, B and C check (progressive maintenance), operational check (airframe overhaul), engine overhaul requirements expected for each type of delta aircraft. White-on-black figures emphasize entry of new aircraft types into maintenance picture. Required seat-mile forecast (below) shows excess of capacity in 1960 as jet operations begin.



tained their data from sources which included Delta's experience with piston planes, Civil Aeronautics Administration past requirements, military experience with jets, manufacturers' estimates, comparisons of the complexity of each ailment of the jet with each element of the piston plane, evaluations of manufacturers' endurance tests and prototype evaluation. Projections considered potential improvements in learning curves, engineering modifications, changes in operating conditions, shortening of intervals when fatigue limits are approached.

Basic overhaul interval of the J57 and J47 engines at a 15% premature failure rate as of Dec. 31, 1956, are estimated in the study as 200 hours and 400 hours respectively.

The interval of the J79, at a 50% premature rate, is put at 160 hours for the same date.

By Dec. 31, 1960, the intervals at a

15% premature rate are projected at 460 hours for the J57, 400 hours for the J79. The J47 will have dropped out of the picture by this time. Curve of the other two engines levels off in 1965 at a 1,050 hr. interval for the J57 and a 1,000 hr. interval for the J79. By 1975, both engines have attained the usual CAA maximum of 1,400 hr.

Turboprop engines, the study predicts, will achieve 1,200-hr. average overhaul intervals by 1970 and 1,400-hour intervals by 1975. Capital Airlines has attained a 1,500 hr. figure with its Rolls-Royce Darts.

With its projections of flying hours and overhaul intervals established, CMP then calculated the number of A, B and C operational checks and engine overhauls required during the transition from pistons to jets and turboprops, and also at five-year intervals between the end of August, 1959 and the end of 1975. Their estimates:

- **Jet engine overhauls** will peak in 1960 at a total of 536 for that year, decline to 317 in 1965 as overhaul intervals increase rapidly. Traffic increases from 1965 to 1975 are greater than overhaul interval increases, so the overhaul totals begin to rise again that year, reach 460 in 1975.
- **Jet A, B and C checks** rise gradually over the period as more of the aircraft go into service. Total for 1960 is 506, total for 1975 is 1,180.
- **Jet operational checks** increase gradually, level off between 1960 and 1965 and total 53 for the latter year.
- **Turboprop engine overhauls** total 406 in 1975. A, B and C checks for that year are 1,040, operational checks are 95.

Final requirement for the calculation of total manpower Delta will need for its maintenance and overhaul work were labor standards for each check and overhaul.

CMP developed piston aircraft labor standards from existing man-hour data, compared each element of DC-7 maintenance with jet maintenance to establish DC-8 and 880 figures:

- **Convair 880 A, B and C** checks will require 40% more man-hours than a similar DC-7 check, or a total of 405 man-hours. Aircraft's operational checks will require 8,016 man-hours, up 21%.
- **DC-8 A, B and C** checks will require 448 man-hours, a 55% increase over the DC-7. Operational check figure is 8,476 man-hours, a 28% increase.

Man-hour requirements for jet engines were developed from material from military overhaul facilities at Ocama and Castle AFB; from Pratt & Whitney and General Electric; from other airlines' planning groups; and from Pacific Airmotive and Southwest Airmotive, subcontract overhaulers. Results:

- **CJ805 (J79) on the 880** will require 723 man-hours for overhaul.
- **JT3C-4 (J57) on the DC-8** will require 767 man-hours.

To both of the above standards, CMP added 34% for unscheduled maintenance and 10% for unallocated man-hours.

After the first 120 overhauls, an improvement of 5% per year for the next five years in engine overhaul time is predicted on the basis of learning experience data available. General Electric's experience with its first jet engine showed 227% of standard man-hours at the start of overhaul operations, 146% by the time 120 engines were overhauled. Southwest Airmotive's J57 learning forecast shows 250% of standard at start, 100% at end of first year.

Need for Training

Overall, the study predicts peak Delta requirements for combined checks and overhauls in September 1960 at 2.4 million man-hours, and in December 1962 at 2.3-million man-hours.

Peaks in man-hour requirements, the report warns, indicate "pressing need for intensive training on jet overhaul prior to the start of jet operations to change the timing of learning curve peaks."

Having established its work and manpower estimates, the consultant firm began preparing block layouts of overhaul and maintenance facilities needed as of Dec. 31, 1960. The layouts are expected to provide for expansion through 1975 and to serve as a basis for architectural drawings of aircraft and engine shop buildings and hangars.

In a sample block layout of a turbine overhaul facility, CMP assumes a five-day, two-shift operation, which it found desirable for most engine overhaul departments. Features are:

- **Material handling** minimized by U-shaped arrangement of departments, fitting the basic materials flow pattern from receiving through disassembly and repair and assembly to engine test.
- **Flexibility in handling** by provision of rolling parts racks, or by substitution of conveyors for the racks.
- **Allowance for unknown** equipment requirements of 25% additional area in each department.
- **Most fixed installation** along one wall of the building, allowing growth in three directions.

In determining what facilities Delta would need for the jet age, Cresap, McCormick and Paget evaluated the economic advantages and disadvantages of handling all maintenance and overhaul functions in a single facility as opposed to splitting them into various combinations. Also considered was possible saving by use of present Atlanta facilities.

The firm found that operational checks and engine overhauls could be most economically combined in a new facility. Separation of A, B and C checks from the overhaul base, it was decided, would result in some disadvantages, but these would be outweighed by increased flexibility of traffic and maintenance scheduling.

The disadvantages listed for such separation included increased supervisory cost, engine investment and shipping costs.

Building area required for all direct maintenance and overhaul operations for 1960 was tentatively established at 520,743 sq. ft. for the completely-combined facility, 539,532 sq. ft. for the arrangement chosen. Equipment investment for the former was estimated at $3,562,099, for the latter at $3,848,519.

Base Location

After deciding that operational checks and engine overhauls should be combined and A, B and C checks done in a separate facility, CMP went on to study various possible locations for the bases. All major terminal points in Delta's present route structure were analyzed in this connection.

Factors considered included:

- **Capital costs**—building, moving, training, personnel moving, financing.
- **Annual operating costs**—direct labor, land-lease, taxes, freight, fire insurance, heating.
- **Intangibles**—union influence, land, plane scheduling to overhaul, weather, potential route expansion.

Having provided Delta with a blueprint of what its jet age maintenance and overhaul requirements will be, CMP set up a schedule for plans to move ahead. Schedule calls for construction to begin late this year and for completion of facilities by fall, 1959.

Cresap, McCormick and Paget will continue to work with Delta up to the actual start of facility construction, Beggs said, to keep abreast of last-minute developments. CMP's major contribution, according to Beggs, is a method of planning, a framework of analysis techniques. Delta can carry on from there.

The consultant's report comments that progressive airline companies will need to make more studies of such problems as ground handling and transportation to maintain and improve their competitive positions. Management decisions in areas as routes, schedules, service and equipment will affect maintenance requirements and thorough planning is a must for survival.

While the services of such consultants may be desirable from time to time, most planning should be carried out by the airlines, the report concludes.

SIKORSKY S-58 in Chicago Helicopter Airways markings. Company was scheduled to put first of its S-58s in service today.

Chicago Helicopter Sees Traffic Record

By L. L. Doty

Chicago—Chicago Helicopter Airways, last of the three scheduled U.S. helicopter lines to begin passenger service, expects to lead the industry by the end of 1957. Current estimates predict an all-time traffic record of more than 100,000 passengers for the year.

Last year, New York Airways, which introduced the first helicopter passenger service on July 8, 1953, carried 43,205 passengers, while Los Angeles Airways handled 20,419. The Los Angeles carrier inaugurated passenger service Nov. 22, 1954; Chicago on Nov. 12, 1956.

S-58 Service

The Chicago company is scheduled to begin service today with the first of three 12-passenger S-58 helicopters it has on order. It expects the increased seat capacity to boost its passenger volume for June over the 5,000 mark, a record passed only once before when New York Airways carried 5,150 passengers last October.

Chicago Helicopter moved 3,709 passengers in May with its fleet of three seven-passenger S-55s to top Los Angeles Airways for the first time.

Key steps taken by the Chicago helicopter line to break into the passenger market were:

- **Expansion program** undertaken last year included an investment of $1.7 million for the new helicopters, ground equipment and hangar facilities.
- **Traffic and sales department** was organized last year to handle the introduction of passenger service facilities and personnel and to increase emphasis upon sales promotion activities.
- **Plans to increase scope** of passenger service will be introduced this fall by transferring S-55 operations to Northern Indiana cities and Chicago North Shore suburbs. At present, the airline's 78 daily passenger flights are confined to the triangle routes between O'Hare Airport, Midway Airport and the Chicago Loop served through Meigs Field on the downtown lake front. The triangle route will be covered by the S-58s.
- **Development of a commuter ticket** book of 10 tickets to sell for $50 for passage on the triangle route. Fare between any two points on the triangle is $5.50 one-way, including tax.
- **Extensive interline relations program** has proved to be a successful outlet in exposing travelers to the helicopter service. A recent survey of 526 passengers during the first four months of 1957 showed that 151 travelers learned of the service from other airlines as compared with 95 who knew of the service through newspaper advertising and 24 through radio advertising.

Traffic Growth

Enthusiasm of Chicago's management for passenger traffic development is reflected in the growth of business since passenger schedules were inaugurated between Midway and O'Hare airports last November. In November, the airline carried 425 passengers. By January, the total had increased to 1,043 and in April, it climbed to 1,752 passengers.

Service from the two airports to downtown Chicago began in April and traffic on these two sectors of the triangle is following a rising trend similar to that established on the original O'Hare-Midway route. For example, although the Midway-Loop segment accounted for only 700 of the 3,709 passengers carried in May, the line is forecasting an increase on this route to more than 1,200 for June.

Chicago Helicopter makes a constant effort to cater to passengers and stresses convenience and passenger comfort in its internal traffic programs.

In a move to increase general acceptance of the helicopter, it distributes booklets explaining the principles of helicopter performance in non-technical language. Airport ticket offices are well-staffed and centrally located.

However, Chicago Helicopter is in an enviable position to develop passenger traffic since it enjoys several of the advantages held by the Los Angeles and New York carriers but is not hampered by some of the disadvantages that plague these two carriers.

Chicago's Advantages

For example, Chicago Helicopter serves a high-density, multiple airport complex. This is also available to New York Airways for traffic development, but not to Los Angeles. But New York is ham-strung by a number of tight air traffic control flight restrictions in the airport and Manhattan areas, while Chicago is free to operate throughout the Chicago metropolitan area on flight patterns that permit a direct flow of traffic.

Comparison of the three helicopter lines for any purpose is unfair at best and is not a true measure of relative progress. The route structure of each carrier differs to some degree and each is faced with its own unusual traffic and operational requirements.

An Air Transport Assn. official re-

CHICAGO skyline is backdrop for an Sikorsky S-55 operated by the Chicago carrier.

cently cautioned that "there can be no common denominator in solving the problems and needs of the scheduled helicopter industry." However, some comparison is essential to an understanding of the basic issues involved in the development of helicopter passenger traffic.

Los Angeles Airways is confined entirely to suburban schedules that are relatively long-haul in nature, while New York and Chicago are focusing attention upon the development of traffic between airports and from airports to the downtown sections.

New York Penalized

But New York is required to conform to zigzag and circuitous routings because of air traffic control complexities and terrain obstacles within its operating area. The airline is compelled to fly over Manhattan at 1,500 ft. on flights between LaGuardia and the West 30th St. heliport and frequently suffers from a payload penalty because of a requirement calling for flotation gear on the S-58s.

Helicopter ingress and egress at both Midway and O'Hare is divorced from fixed wing operations, and CHA's routes pass over no skyscrapers which means no unreasonable altitude limitations.

Both carriers recognize the potential passenger traffic within each metropolitan area because of slow ground transportation facilities and lack of sufficient throughways or express highways.

It has been estimated that it takes a passenger 79% as long to travel from Midway to the Chicago loop as it does to fly from St. Louis to Midway. In New York, taxi and limousines are slowed by 58 traffic signals between central Manhattan and Idlewild.

Chicago Helicopter, however, holds an advantage over the New York line since the Chicago business area is compressed into a smaller, more centralized section than New York. Thus, the Chicago heliport at Meigs Field is more conveniently located for business.

Intercity Flights

In addition to its inter-airport service, New York Airways operates passenger flights five days weekly on two inter-urban legs—from LaGuardia, Newark and Idlewild airports to White Plains, N. Y. and Stamford, Conn. on the north and to New Brunswick and Trenton, N. J., on the south. It is unlikely that Chicago Helicopter will serve its suburban area with a substantially greater frequency of flights with its present equipment.

The three helicopter carriers are convinced that successes gained in the inter-airport operations of Chicago and New York prove the need for increased frequency of flights in inter-community operations if the full passenger traffic potential is to be realized.

Los Angeles Operations

Los Angeles Airways, first of the helicopter lines to be certificated, covers the largest area of the three companies and has made several pleas before the Civil Aeronautics Board for authority to augment its fleet of six S-55s and two S-51s in order to step up schedule frequency.

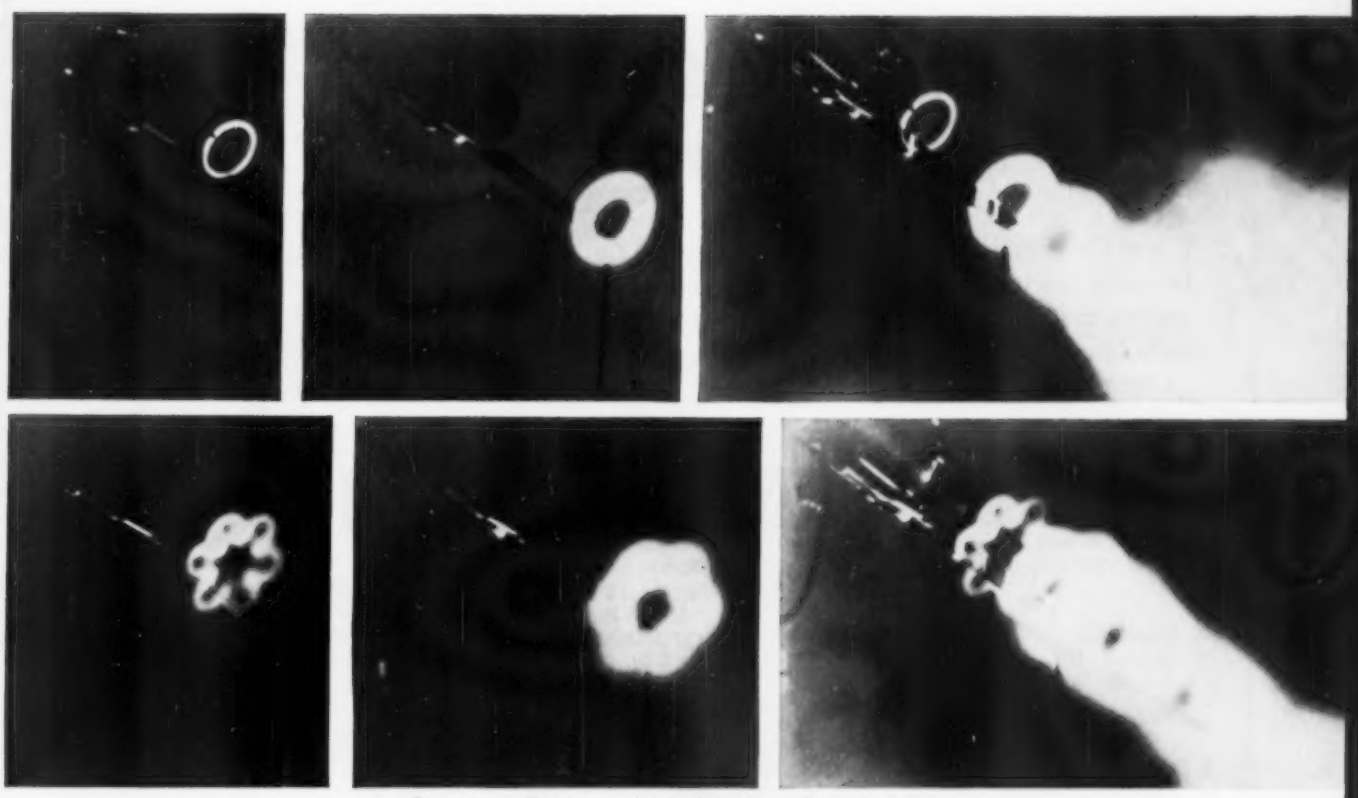
Average passenger trip on LAA is 36 miles, a distance, the airline points out, that is generally too long for car and too short for fixed wing service. During the third quarter of 1956, LAA carried fewer passengers than NYA but flew more passenger-miles.

In May, Los Angeles moved 2,650 passengers, close to capacity, and is creating an average waiting-list of 25 to 30 passengers daily.

LAA's passenger revenues in 1956 exceeded either mail or express, and the airline recently told the CAB that "the present level of service offered by Los Angeles Airways is inadequate to meet the day-to-day demands." It warned that low flight frequency will have a deterring effect on helicopter passenger traffic growth and added:

"If the passenger is consistently unable to get space on the more desirable flights, he will soon refuse to use any of our flights at all and, as a result, the demand for all flights decreases."

INTERIOR of S-55 includes bench type seats, telephone from cabin to pilot.



Smoke Rings Aid Noise Study

Visual study of jet exhaust turbulence is made possible by Douglas Aircraft Co. engineers with smoke introduced into jet stream and illuminated by slices of light. Method shows difference between unaltered and altered exhausts and aids DC-8 noise suppressor work. First two photos left to right in top line above show exhaust one diameter and four diameters downstream of jet, respectively, without suppressor. In first two photos left to right in bottom line, exhaust is quickly diffused by suppressor two and four diameters, respectively. Photo at top right is composite of unsuppressed exhaust at various distances; at right below, suppressed exhaust at various distances.

In a statement issued last January, the Board found that increases in the scope of the carrier's subsidized operations are not warranted "unless it can show that such increases will produce developmental benefits offsetting the increases in subsidy."

It explained "the primary reason that Los Angeles was certificated by the Board was to encourage the development of rotary-wing aircraft as a means of transportation, rather than to meet service demands" and added that the "justification for the considerable amount of subsidy that was envisioned for an operation covering one metropolitan area was the need for experimentation with the helicopter."

In addition to the three S-55s and the three S-58s which it will have in full operation next month, Chicago Helicopter Airways operates six Bell 47G helicopters with which it began service between Midway and the roof of the 13-story Post Office Building in downtown Chicago in August, 1949.

The airline later expanded its all-mail service with the 47Gs to cover 32 heliports in the Chicago suburban area, thereby serving some 55 separate communities. By January, the airline had transported 21 million lb. of mail with the 47Gs and had accumulated 45,000 hours of flight time while completing 96% of schedules.

CHA plans to phase out a part, if not all, of its B-47Gs late this year. Interest on its present equipment loan approximated $4,300 in May and will increase to $6,250 this month. The airline is seeking an adjusted temporary rate of mail rate that will provide an average monthly compensation of $84,615.

The company operates under a seven year certificate granted in August, 1956 by the CAB to carry passengers, property and mail over established routes and a seven-year exemption authority to carry passengers between any points within a 60-mile radius of O'Hare Field.

Operating revenues in 1956 were $631,355 as compared with $513,709 for the previous year. Operating expenses amounted to $633,354 in 1957 and $461,176 in 1956.

Funds for the purchase of equipment were raised with a four-year $1.5 million bank loan and the offering of 23,050 shares of additional common stock to stockholders which amounted to $259,313 and increased the combined capital stock and surplus accounts to $721,030 as of December, 1956.

John S. Gleason is president and treasurer of CHA executive vice president is C. W. Moore. Other officers include John C. Brogan, vice president-secretary; Robert S. Angstadt, vice president-operations, and Robert B. Kiel, assistant secretary and assistant treasurer.

Texas-Holland Service By KLM in September

KLM Royal Dutch Airlines has set Sept. 3 as the date of the inaugural flight over its new Houston-Amsterdam transatlantic route.

First flight is scheduled to leave Schiphol airport at 11 A.M. and arrive in Houston at 3:45 P.M. on Sept. 4 (local times). The DC-7C will stop at Shannon and Montreal.

Initial departure from Houston will be on Sept. 6, with a stop only at Montreal. Elapsed time of the 5,100-mi. flight is scheduled as 18 hours.

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Convair F-102-A

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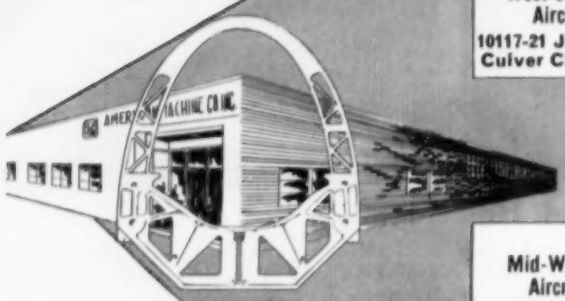
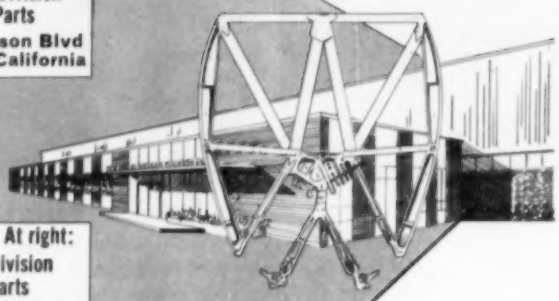
At left:
West Coast Division
Aircraft Parts
10117-21 Jefferson Blvd
Culver City, California





At right:
Mid-West Division
Aircraft Parts
1450 E. 19th Street
Indianapolis, Indiana

Illustrated above are typical structural machined aircraft parts and assemblies currently being manufactured in the two divisions. The aircraft divisions operate under Air Force approved Quality Control systems. Each division possesses the most up-to-date equipment for its specialty including many pieces of equipment designed around a particular part. . . . . .

Convair B-58

Boeing B-52

H&B AMERICAN MACHINE CO., INC.

General Offices: Prudential Plaza, Chicago 1, Illinois

SHORTLINES

▶ **National Safety Council** gave the Award of Honor to 36 U.S. airlines for flying their 1956 schedules without a passenger or crew fatality. The overall fatality rate for scheduled U.S. airlines in 1956 was .62 deaths per 100 million passenger-miles and marked the fifth consecutive year that the rate has been below 1.00. The best previous rate was .09 in 1954.

▶ **Ozark Air Lines** established a new traffic record during May by flying 37,030 passengers, an increase of 9,232 over the same month of 1956. The best previous month was last October when the airline flew 34,348 passengers.

▶ **Allegheny Airlines** flew 6,786,400 passenger-miles during May to set a new record for the month. May passenger traffic was 13% higher than that for the same month of 1956. During the five months from January through May, Allegheny flew 27,031,326 passenger-miles and reported an increase of 57% in air express and air freight during the period January through April.

▶ **Southern Airways** set a new record for the month of May by carrying 19,200 passengers a total of 3,300,000 passenger-miles. This mileage figure is up 22% over May of 1956. In the first five months of 1957 Southern flew 85,700 passengers 14,750,000 passenger-miles, up 16% over the same period in 1956.

▶ **Philadelphia International Airport** reports a 22% increase in passenger arrivals and departures for the first four months of 1957—454,916 passengers landed or flew out of the field, 90,000 more than the January through April period in 1956.

▶ **Port of Seattle, Wash.**, will negotiate a ground lease of 324,000 sq. ft. of land with Pacific Northern Airlines for a $1,500,000 headquarters, repair base and hangar at Seattle-Tacoma International Airport. The Port authorities also announced tentative agreement with seven lines using Seattle-Tacoma on higher landing fees, which will increase airport income an estimated $70,000 a year.

▶ **British Overseas Airways Corp.** is reexamining prospects of reopening the services between the United Kingdom and South America. A survey party is now touring South America. BOAC suspended South American operations in April, 1954, when the Comet was withdrawn from its fleet.

AIRLINE OBSERVER

▶ Watch for concerted pressure on the State Department by European countries for a review of the Civil Aeronautics Board decision to turn down the proposed 15% fare increase on transatlantic flights (AW June 10, p. 45). Great Britain has already filed a protest, warning that the international cooperative system of airline operations may be threatened if one country continues to veto the desires of all the others involved. Other countries representing major transatlantic flag carriers are expected to follow Britain's lead in protesting the CAB decision.

▶ **Prospects are good for adoption of IFR requirements for all airline flights operating over the "Golden Triangle" routes between New York, Washington and Chicago above 9,500 ft. The plan was originally proposed by the Air Line Pilots Assn. (AW May 6, p. 40) and most airlines appear to be in accord with the measure. Approval of the program by the Air Transport Assn. is expected in time to permit the introduction of the system sometime this summer.**

▶ Pan American World Airways has replaced hollow-steel bladed propellers on its fleet of 25 Boeing Stratocruisers with solid dural bladed propellers at a cost of $1.7 million. Both types of propellers are manufactured by Hamilton Standard, United Aircraft Service Corp.

▶ **Civil Aeronautics Board Examiner James Keith has recommended disapproval of a Railway Express Co. application to boost COD rates by 7% and increase excess valuation charges from 18 to 19 cents per $100 values in excess of liability allowed.**

▶ Russian Tu-104 jet transport flew from Le Bourget Airport, Paris, direct to Moscow in three hours, three minutes after being on static and flying display at the 22nd International Aeronautical Salon. Transport made the Moscow-Paris flight in three hours thirty minutes (AW June 10, p. 26). Regular Paris-Moscow air service, via Prague, takes about 12 hours. Air France has resumed negotiations with Aeroflot and the Soviet government and is now discussing direct Paris-Moscow operating rights.

▶ **Rolls-Royce will construct an $800,000 depot for engine service and spares warehousing in Fairfax County, Va., about 10 miles from Washington. Main beneficiary will be Capital Airlines whose Vickers Viscount turboprop transports are powered by Rolls-Royce Dart engines.**

▶ Bias charges have been brought against Trans World Airlines as a result of a complaint by Dorothy Franklin of New York that she was refused a job as a stewardess because she is a Negro. The New York State Commission Against Discrimination has set July 9 as the date for public hearings on the case.

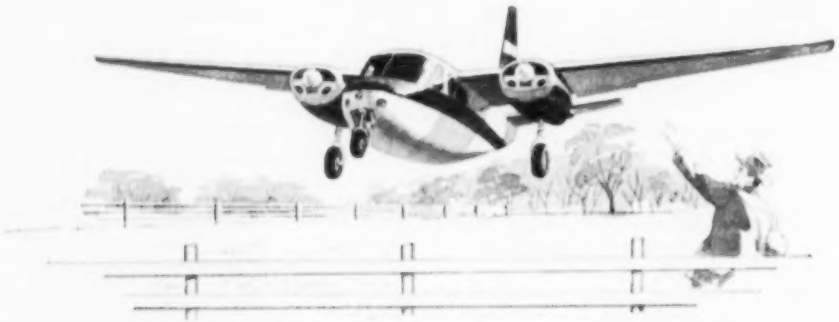
▶ **Air Traffic Controllers Assn. has asked Secretary of State John Foster Dulles to consider air traffic control problems in any agreement with the Soviet Union on President Eisenhower's Open Skies inspection policy.**

▶ Union Aeromaritime de Transport, private French airline, has ordered three additional Nord 2502 Noratlas passenger-cargo aircraft. The company now operates four Noratlas aircraft, and the new equipment will be used on UAT's African routes. The 2502 differs from the usual Noratlas in that it is equipped with two Turbomeca Marbore auxiliary jets mounted on the wingtips. The three aircraft are slated for delivery in 1958.

▶ **Civil Aeronautics Board has voted to defer a decision on the proposed transfer of Trans World Airlines' Cincinnati-Detroit route for consideration with its decision on the Great Lakes-Southeast case. During the New York-Chicago service case, TWA said it would be willing to transfer the route to another carrier if Detroit were designated as an intermediate point on the airline's New York-Chicago route. The Board granted the Detroit stop to TWA and then instituted an investigation to determine disposition of the Cincinnati-Detroit route.**

what's your ACIQ ?*

	560-E	680-Super
High Speed, rated power—10,000 ft.	222 mph	260 mph
Cruising Speed, 70%—10,000 ft.	210 mph	230 mph
Stall Speed, gear and flaps down, power off	66 mph	71 mph
Take-off Distance to clear 50-ft. obstacle at S/L	1,452 ft.	1,540 ft.
Landing Distance to clear 50-ft. obstacle at S/L	1,500 ft.	1,625 ft.
Gross Weight	6,500 lbs.	7,000 lbs.
Useful Load	2,200 lbs.	2,670 lbs.
Range, with 30-minute reserve	1,625 mi.	1,480 mi.
Service Ceiling, 2 engines	22,500 ft.	24,200 ft.
Ceiling, one engine	8,000 ft.	15,000 ft.
Rate of Climb, S/L	1,450 ft/m	1,600 ft/m



short-field performance

Actually, Aero Commanders are operating daily out of small sod fields all over the country. Timber men in the Northwest, oil operators on the plains and sand beaches, construction men at remote job sites—all give testimony to the versatility of this executive transport. The take-off and landing figures above are based on a full gas load.

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Airline Traffic — April, 1957

	Revenue Passengers	Revenue Passenger Miles (000)	Load Factor	U. S. Mail	Express	Freight	Total Revenue Ton-Miles	Per Cent Revenue to Available Ton-Miles
DOMESTIC TRUNK								
American	637,874	405,751	66.2	1,609,584	707,772	6,512,058	47,927,361	59.6
Braniff	165,274	70,019	59.9	255,963	112,054	396,220	7,476,815	48.9
Capital	320,520	121,598	60.9	375,877	161,708	298,892	12,500,934	48.8
Continental	62,656	23,353	55.1	74,485	22,222	105,694	2,444,876	46.5
Delta	228,205	117,262	62.6	345,316	205,473	656,360	12,491,942	57.6
Eastern	701,994	421,597	61.76	922,186	*	1,326,552	43,325,729	*
National	145,865	101,557	61.1	302,473	54,741	510,825	10,702,985	50.9
Northeast	48,083	13,413	47.8	16,565	13,451	41,616	1,354,430	40.3
Northwest	105,326	67,632	55.2	398,491	170,347	736,406	7,805,120	49.0
Trans-World	365,035	272,571	62.7	1,108,219	573,195	2,079,142	29,950,107	56.0
United	490,284	345,359	62.5	2,349,282	689,806	4,261,915	40,465,547	54.4
Western	104,526	49,853	62.3	246,508	85,515	203,461	5,314,444	57.7
INTERNATIONAL								
American	11,310	8,242	60.8	12,351	308	283,002	1,171,714	67.0
Braniff	3,042	6,520	52.1	18,204	.....	60,681	793,438	53.7
Caribbean-Atlantic	21,363	1,489	53.67	1,410	.....	3,227	161,408	58.67
Delta	5,142	5,943	54.4	7,109	.....	63,630	734,252	49.0
Eastern	23,213	30,776	62.47	83,442	*	71,723	3,363,853	*
National	6,719	4,621	44.8	9,209	3,948	29,650	523,405	44.5
Northwest	9,075	19,210	52.3	963,138	20,230	617,027	3,645,318	65.1
Pan American								
Alaska	5,201	5,477	48.0	40,428	.....	232,792	850,220	44.6
Atlantic	86,213	108,152	66.0	1,192,244	.....	1,914,619	14,572,793	63.5
Latin America	94,952	96,942	62.6	337,887	.....	3,536,245	13,297,881	60.3
Pacific	22,733	93,124	78.0	1,035,303	.....	1,551,497	12,476,378	71.3
Panagra	12,477	15,446	60.9	57,043	.....	385,913	2,096,137	62.2
Trans-World	20,379	46,561	67.9	785,390	.....	697,435	6,407,133	71.6
United	6,452	16,171	59.9	107,038	.....	68,745	1,836,028	55.3
LOCAL SERVICE								
Allegheny	32,972	5,870	44.8	8,370	17,053	9,785	595,517	46.0
Bonanza	12,829	2,881	50.0	4,475	2,421	6,073	288,172	48.1
Central	8,729	1,717	30.7	4,276	1,877	5,673	176,551	27.6
Frontier	16,513	4,524	47.0	18,695	8,021	54,220	514,474	56.1
Lake Central	12,469	1,951	38.3	2,252	9,125	.....	197,984	39.9
Mohawk	33,670	6,523	55.4	5,111	10,264	17,075	653,717	55.5
North Central	47,657	7,402	47.1	18,843	23,329	.....	748,399	47.6
Ozark	28,742	4,555	39.5	11,049	13,698	10,425	470,441	41.4
Piedmont	32,822	6,605	54.9	12,618	8,734	10,880	664,359	54.2
Southern	18,102	3,169	47.6	9,036	9,109	.....	321,937	44.6
Southwest	28,108	6,146	54.4	9,651	4,504	5,579	605,546	52.2
Trans-Texas	20,429	4,597	36.6	13,560	6,916	21,071	479,985	36.7
West Coast	19,939	3,572	49.28	4,534	2,287	3,796	351,457	46.47
HAWAIIAN								
Hawaiian*	.....	.....	....	.....	.....	.....	.....	....
Trans-Pacific*	.....	.....	....	.....	.....	.....	.....	....
CARGO LINES								
Aerovias Sud-Americana	.....	.....	....	.....	.....	761,396	761,396	80.2
Flying Tiger	6,631	38,058	99.5	37,921	40,905	6,628,733	10,513,344	82.5
Riddle**	.....	.....	....	49,159	23,492	1,751,338	1,823,989	61.9
Seaboard-Western	1,472	7,874	100.0	.....	.....	1,851,484	2,638,923	72.6
Slick	7,426	26,865	81.21	86,976	55,522	4,097,559	6,926,613	66.15
HELICOPTER								
Chicago Helicopter	2,416	36	28.5	2,300.6	.....	.....	5,752.1	32.0
Los Angeles Airways	2,443	90	53.25	4,263	1,916	.....	14,848	62.03
New York Airways	4,816	88	37.3	1,407†	163	490	11,055	42.4
ALASKAN								
Alaska Airlines	250	394	12.7	16,805	.....	159,839	219,254	34.6
Alaska Coastal	4,012	344	59.9	3,710	.....	3,982	43,038	61.6
Cordova	1,429	494	45.6	3,059	.....	119,576	172,543	43.1
Ellis	4,199	231	57.3	1,681	.....	2,951	28,217	70.0
Pacific-Northern	6,755	6,221	44.3	79,144	.....	243,551	998,708	54.8

*Not available.
**Domestic figure only.
†Mail transferred in bulk.
Compiled by AVIATION WEEK from airline reports to the Civil Aeronautics Board.

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Profile of a New Approach to a Carrier Landing

As he whistles in for a carrier landing, the Crusader pilot has the full forward visibility he so vitally needs.

Up above the cirrus, he has the slashing, 1,000-mph-plus speed that assures air superiority.

By all that governs carrier fighter design, he should be entitled only to *one or the other* of these two features. But Vought engineers conceived a variable incidence wing which enables the Crusader to give him both.

They developed a continuous wing, attached to the Crusader fuselage by pivot lugs at the trailing edge and by a hydraulic strut near the leading edge. Prior to landing, the wing may be tilted into desired approach attitude. The fuselage, meantime, remains almost horizon-level—and the pilot has a straight-on view of landing signals and the oncoming deck.

By achieving full approach visibility without elevating the pilot seat, Vought engineers have kept the Crusader canopy small, simple, sleek. This minimizes fuselage drag, and is a major factor in the Crusader's Thompson Trophy-winning speed.

Typically, the Crusader's developers approached their assignment with firsthand operations analysis, completed it with technical free-thinking. Again, they came up with an original weapon . . . and an important new concept as well.

4 IMMEDIATE OPENINGS FOR ENGINEERS

Senior Flight Test Engineer. To plan and direct flight tests of fighter and photographic-type aircraft in all phases of flight test. Requires engineering degree or equivalent, and 3 to 4 years related experience. Pilot experience applicable.

Senior Structures Design Engineer—Guided Missiles. For assignments in the structural design and stress analysis of advanced missile systems. Degree in engineering and 3 to 6 years of structural design experience.

Lead Structures Design Engineer. To assume responsibility for structural design integrity of a primary component and responsibility for structural development work. Requires engineering degree, supervisory ability and 6 to 10 years related experience.

Propulsion Engineer. For assignment in installed turbojet and rocket performance; thermal control; inlet duct and nozzle design; aerothermodynamics.

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TIGHT FORMATION landing made by Italian team in Canadair Sabre IVs on first day of Paris show was sensation of display. Team is approaching touchdown with gear and speed brakes extended, flaps down.

Teams From

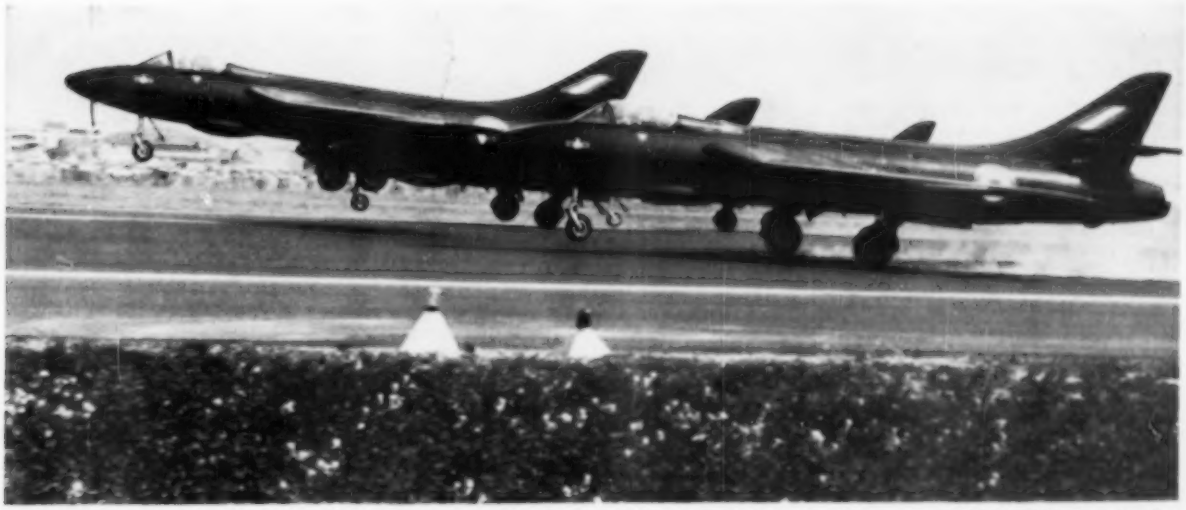
ITALIANS peel off from top of formation loop into bomb burst break-up, trailing smoke from their wing smoke pots and rolling out into the four directions of the compass.

Paris—International acrobatic competition by five teams of jet aircraft flown by pilots representing four nations highlighted the final two days of the flying display of the 22nd International Aeronautical Salon Le Bourget Airport.

French were represented by two teams consisting of four air force pilots flying Dassault Mystere IVA fighters now in service with the French Armee de l'Air and three instructors from the French military flying school flying Fouga Magister jet trainers.

Royal Air Force had an acrobatic team from 111 Squadron flying Hawker Hunters in unique five-plane acrobatic formations featuring position changeovers during maneuvers.

USAF entered the Skyblazers now using North American F-100Cs and flown by pilots of the 36th Fighter Wing, 12th Air Force in Germany. Italians fielded a quartet of pilots in Canadair built Sabre Mark IVs. Italians carried off honors the first day with their tight diamond box formation landing while the Skyblazers and Royal Air Force Hunter team dueled for top rating the second day. Hunters scored with their special five-plane formations advancing jet acrobatics another notch in intricacy while the Skyblazers featured precise flying and air discipline coupled with spectacular use of the afterburners on their J57 turbojets.



RESPONDING to Italian challenge, Royal Air Force team from 111 Squadron flying Rolls-Royce Avon powered Hawker Hunters, touches down in five plane formation landing. Fifth Hunter is in rear of formation and not visible in picture. Note tire smoke from main wheels of rear Hunter. Addition of fifth man to conventional four plane formation was a new element in team displays.

Four Nations Display Acrobatic Prowess

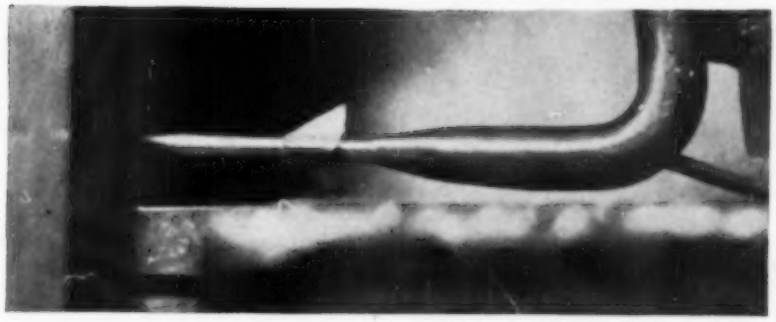
VARIATIONS in diamond box formation by Hunter team included a tight box (left) with fifth man inside, spearhead formation with fifth man shifting to rear (right).

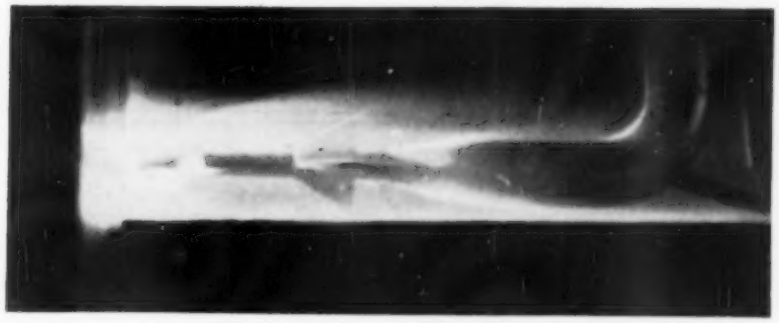
STANDARD four man box formation (left) is led by fifth man to make a point. Echelon formation is flown by five man Hunter team right); British system stressed position changeovers during maneuvers.

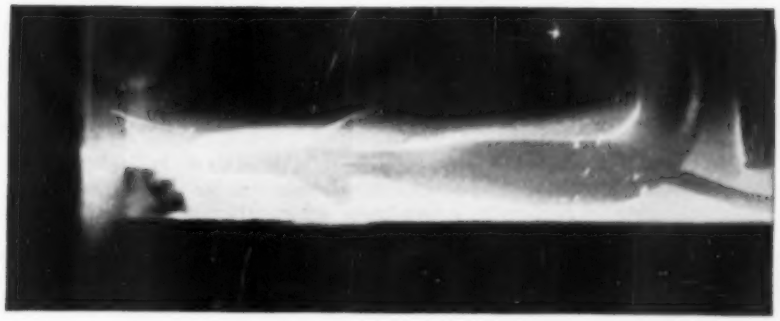
FRENCH MYSTERE IVA team, with fifth man as spare, peels off for landing at Le Bourget (left). Fifth plane laid down sonic booms onto field to mark climaxes in maneuvers flown by the other four planes. Tricolor markings are visible on tails of Mysteres (right). The Dassault fighter is powered by Hispano-Suiza Verdun turbojets.

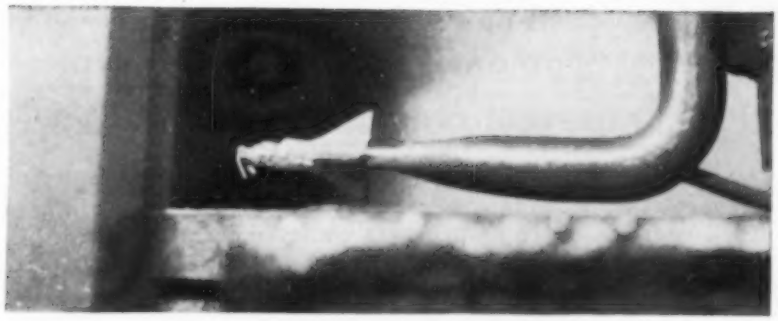
USAF SKYBLAZERS, North American F-100Cs from 36th Fighter Wing, 12th Air Force, Bitburg, Germany, fly tight diamond box formation (left). In same formation, the team climbs to perform formation loop (right). Planes are powered by Pratt & Whitney J-75s.

PULLOUT from formation loop by USAF Skyblazers causes wingtips of F-100s to bend under G loading.









Steel Missile Shape Melts

Temperatures which reached 2,060F on the probe melt down a simple steel missile shape at the Cornell Aeronautical Laboratory. Test, conducted in a jet of high temperature air which reached 2,030F, was carried out in a pilot model of Cornell's continuous flow hypersonic test facility under development for Air Force Office of Scientific Research. In an air jet of Mach 3, the model glows almost instantly and in about one second begins to burn. Luminous air flow escapes from the hollowed nose through bleed holes required for thermocouple action. A hot spot develops behind this point where the thermocouple wires fill the model and a fraction of a second later the model nose melts away. At the end of the three second test, less than 50% of the hollow steel shape body remains.

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Chemical Companies Hear Missile Needs

French Lick, Ind.—Prompted by rising government expenditure on the missile program (currently over $2 billion annually), chemical leaders sought expert commentary on the missile industry's latest propellant requirements at the spring meeting of the Commercial Chemical Development Association held at French Lick, Ind.

Chemical manufacturing firms have showed some hesitancy in the past about entering missile work. This is primarily due to the peculiar character of the market for propellant chemicals and its total dependency on military requirements, which have an inherent characteristic of rapid, drastic change.

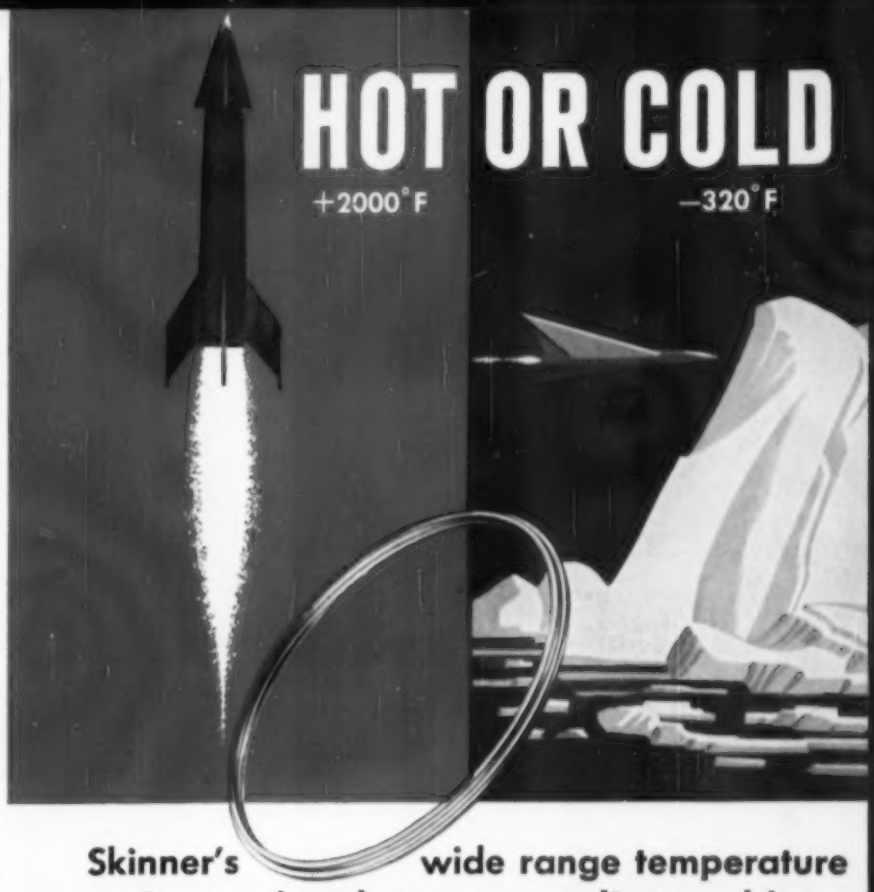
The market for propellants is plagued by a demand curve which was described by Dr. John F. Gall of Pennsalt Chemicals Corp., as resembling a ballistic missile trajectory. Small quantities of the new propellant are needed for property testing and initial work in small scale motors. Then, if the chemical is good enough to enter full-scale acceptance programs, the demand rises quickly to hundreds of tons a month. After the completion of these tests only a small amount of the chemical is needed for operational training of military units, improvement programs, etc.

This undesirable type of demand curve makes it mandatory for a chemical firm to find commercial uses for a missile chemical if its development is to be as profitable as that of a normal commercial chemical. Fortunately many of the constituents of the older rocket fuels and oxidizers have large commercial markets. Progress is reported for commercial uses of some of the newer, relatively high cost propellants, but considerable financial risk is still involved in their development.

General recommendations were for a chemical manufacturing firm to:

- **Obtain security** clearance, which is available for firms interested in the missile market.
- **Study the work** being done, attempting to find immediate use for its process and handling experience. Many improvements have been initiated by commercial firms which have reached economical solutions to missile problems.
- **Recognize** that missile specifications vary widely and that the missile designer's need for chemical industry knowhow is constantly broadening.

The percentage of the total expenditure on missiles which is available to the chemical industry for the development and production of fuels, plastics, etc., has been estimated as high as 30%. The value of the fuel in a single missile, however, is usually well below 5% of the total cost of the missile.



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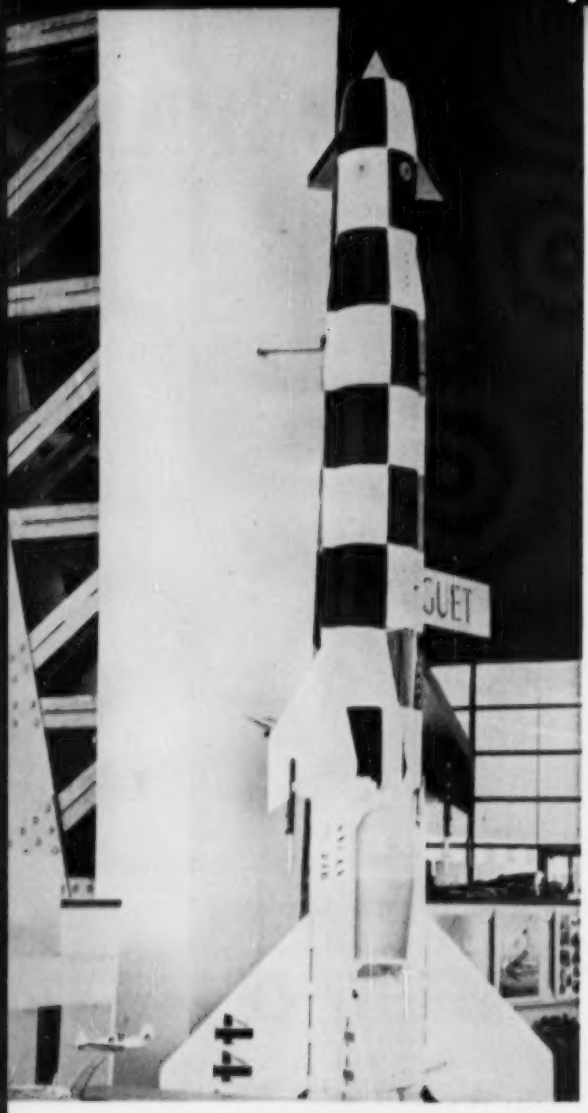
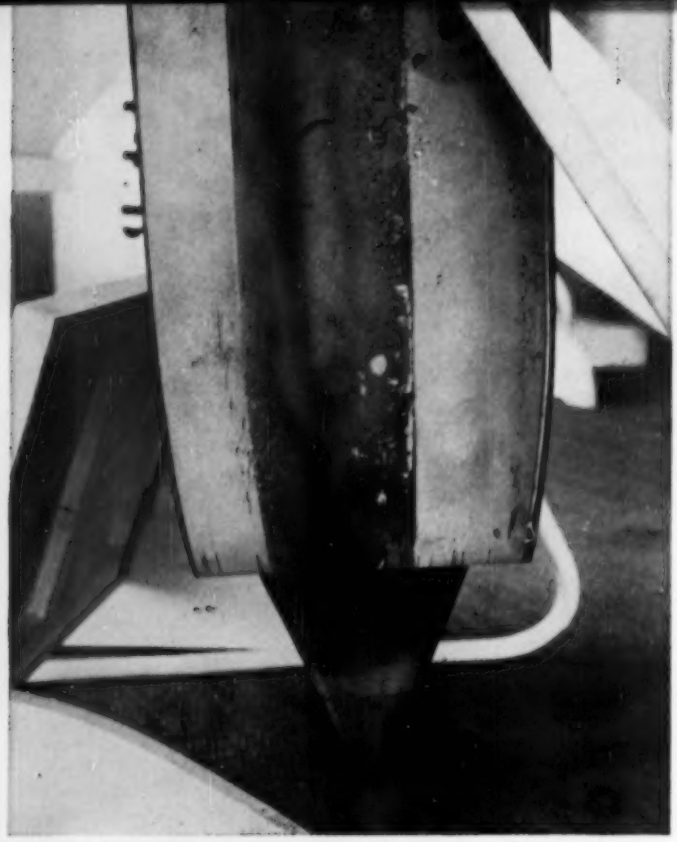




NORD ST 450 ramjet test vehicle (left) is intended for exploration of ramjet properties at three times the speed of sound and altitudes of 65,000 ft. Engine uses single inclined shock, probably operating with spill of the excess air over the cowl lip. Central body is mounted on slim struts fore and aft. Two boosters get the ramjet to operating speed. Round shown on the stand was numbered 44. Recovered ST 450 test vehicle (above), was fired to an altitude in excess of 75,000 ft. and a speed above Mach 3.2. The black and white paint shows burned areas from aerodynamic heating and eroded areas from the highspeed airflow. Note also the gradations of color on the diffuser spike, showing the variation in heat transfer. Spike tip has been burned blunt.

Wide Range of European Missiles Displayed at

NORD 5103 Type J2RT is an air-to-air missile developed for the Gerfaut II and shown at the Salon under the wings of a Sud Aviation "Aquilon" (DH Vampire built under license). Missile is radio-guided, presumably by command link from the fighter. It weighs 297 lb. and is 8.6 ft. long.

MISSILE ENGINEERING

ONERA three-stage test vehicle (left) is part of that government agency's hypersonic aerodynamic program. Last stage is aerodynamic shape fired to get basic data.

SUD AVIATION SE 4300 is experimental surface-to-air test vehicle for guidance system work. It has a liquid fuel rocket motor and uses a large, finned SEPR booster as a first stage.

Paris Air Show

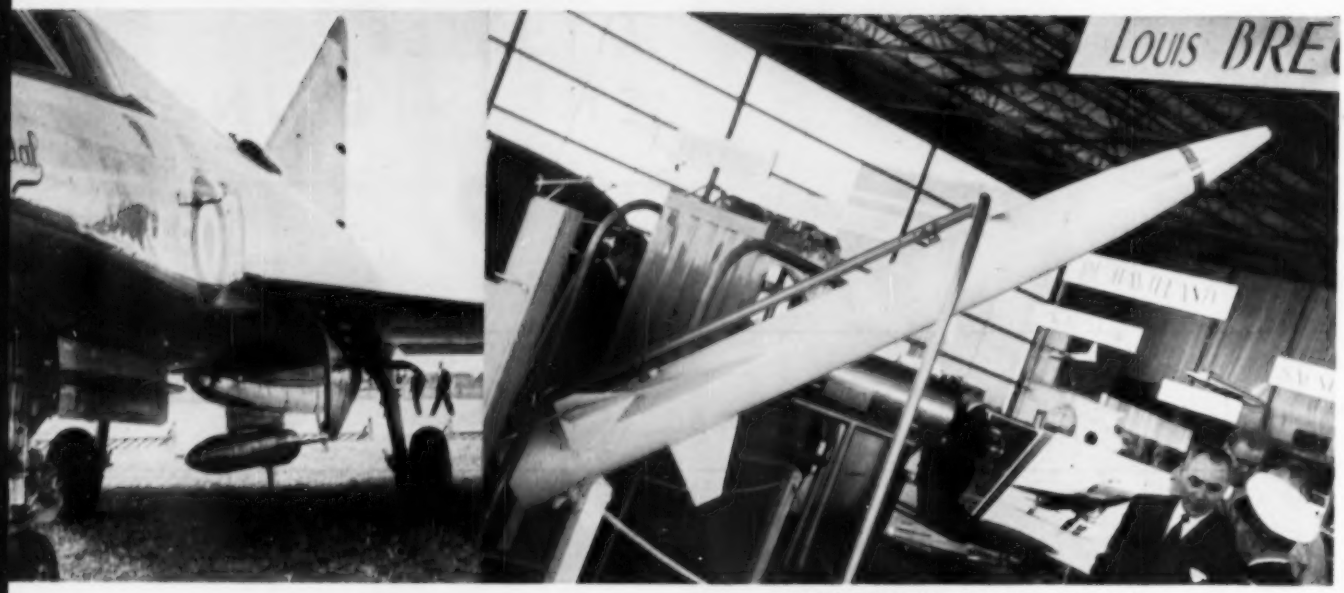
Paris—New French missiles and test vehicles dominated the static displays of the 22nd International Aeronautical Salon at Le Bourget.

A complete range from the subsonic, wire-controlled anti-tank SS 10 missile to a supersonic ramjet vehicle were shown.

British missiles shown included the Bristol Bloodhound interceptor missile powered by a pair of Thor ramjets, the Fairey Fireflash and the English Electric Thunderbird. Both the Bloodhound and Fireflash were prominently displayed near signs that stated the two missiles were available for export.

Top technical interest was shown in a recovered ramjet test vehicle, the ST 450, which had hit a speed of about 2,100 mph. at an altitude of about 75,000 ft. (approximately Mach 3.2).

The sharp spike had burned to a blunt point (top right, page 56) and the temperature patterns caused by the aerodynamically heated air could be clearly seen on the outside of the shell.

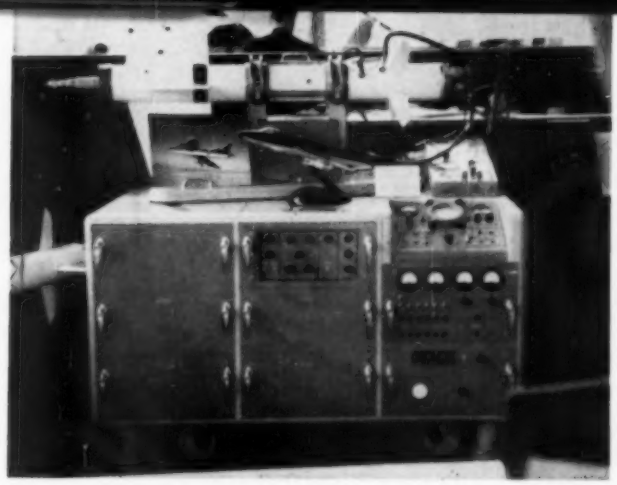


MATRA TYPE 510 air-to-air missile is shown on the company's display stand at the Salon and under the belly of a Sud Aviation Durandal light interceptor.

French Launchers Include Jeeps

SUD AVIATION SE 4200 (left) is a surface-to-surface tactical missile, rocket-boosted and with an air-breathing engine.

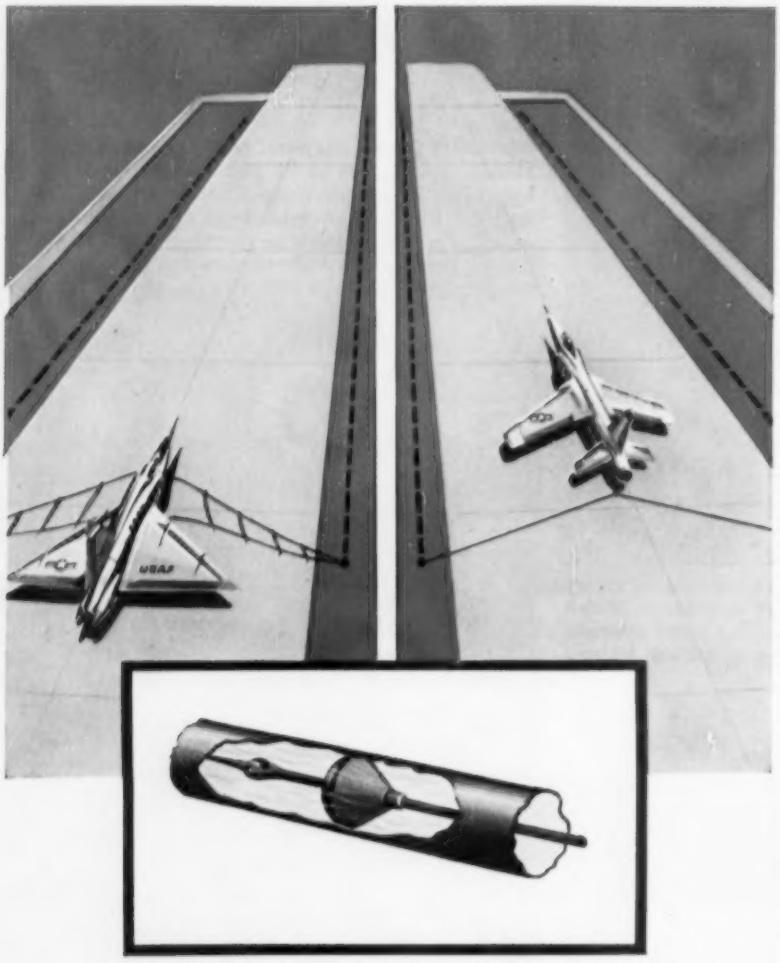
NORD SS 10 anti-tank missile (right) is highly successful standard equipment with the French forces, was also used in Suez war by Israeli Air Force against Egyptian tanks. Installation shown here in Jeep is also available in slightly modified form for trucks, half-tracks or open ground.



CHECKOUT STAND for ground pre-flight check of Fairey Fireflash missile is one of the pieces of that missile system available for export from England. Fireflash is a coaster, is boosted to supersonic speed by a pair of solid-propellant boosters. Models on the stand showed both a Hawker Hunter and a Vickers-Supermarine Swift with a pair of Fireflash missiles in underwing positions.

British Stress Export

ENGLISH ELECTRIC Thunderbird anti-aircraft missile is in production for the British Army, is rocket-powered vehicle boosted from launcher by eight boosters in four pairs. Models shown here are of an early version of a proposed automatic system using underground storage hangars and rails to move the launcher.



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X-10 Control Console Simulates Navaho

New York—Extent of Navaho mission simulation with the X-10 research vehicle was indicated by an X-10 remote control console which was part of a North American Aviation, Inc., exhibit at a recent Society of Automotive Engineers show here. The X-10 as described in AVIATION WEEK (Feb. 4, p. 27 and Feb. 11, p. 29) was designed to do almost everything that the Navaho missile is expected to do and to have the important research bonus of being completely recoverable.

As the remote control console showed, controls and feed-back information are placed in front of the X-10 "pilot." The flight controls are located on the table directly in front of operator. They include an off-on throttle switch, a "dive-in" switch and a knob arrangement at the operator's right hand where he can dial in turn and pitch commands.

Overhead, above the displayed console, an X-Y latitude-longitude plot of the course of the X-10 as if it flew the Patrick AFB down-range was superimposed over a navagating chart of the area. Under this plot, on the upper panel of the console, were dials indicating the condition aboard the X-10. Left to right, the top row displayed radar altitude, pressure altitude, Mach reference and Mach number. Similarly, the second row showed angle of bank, heading, indicated air speed and pitch. The lower row contained, besides two dials blanked off, a gyro and an autopilot sequence indication. All of these indications were sensed aboard the X-10 and telemetered back to the console.

A typical test run, as depicted by NAA movies shown at the exhibit, entailed a short, "hot" take-off with the forward canard flippers in the full positive angle-of-attack position, a rapid

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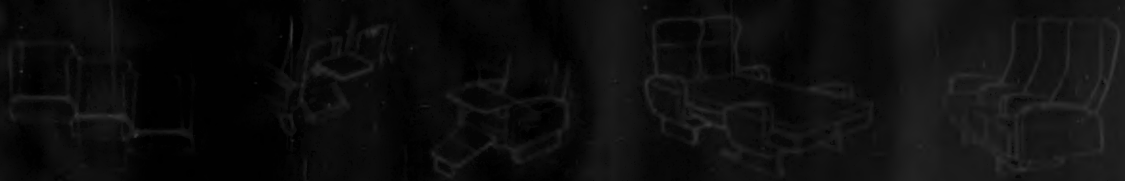

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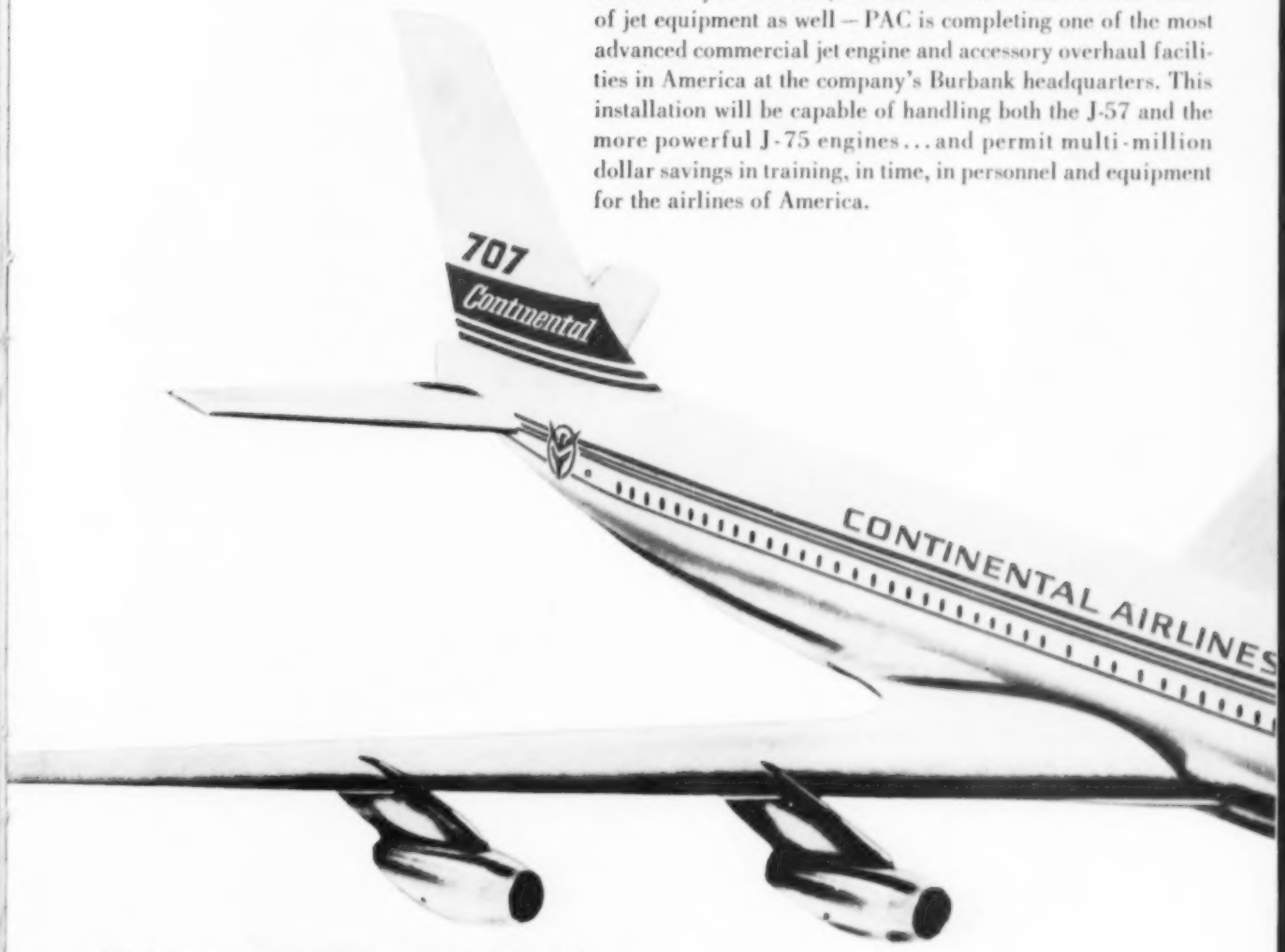

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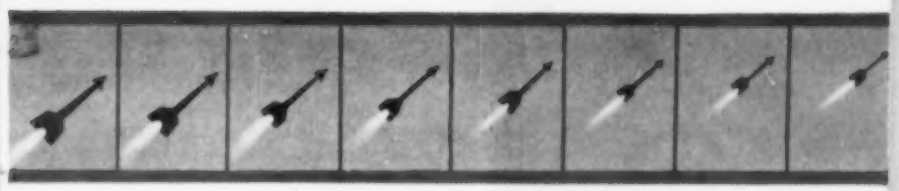
NAVY
Dany Ellis



Robert M. Carbee, a combat fighter pilot in World War II, graduated from M.I.T. and joined Grumman in 1948. Spent nine years in Structural Design, Cockpit Enclosure Design and Armament Engineering, and is now the Assistant Head of the Weapons Systems Engineering Department.

ARMAMENT CONTROL SYSTEMS in the jet age

by ROBERT M. CARBEE

It was found in World War II that a trained pilot under conditions of clear visibility could perform the difficult tasks of attacking and destroying enemy aircraft and ground targets satisfactorily at speeds up to 350 knots through use of his own eyesight, a fixed sight unit and a rough mental calculation of the required lead (though lead computation was seldom actually used). Introduction of the optical lead computing gunsight proved a valuable aid to the combat pilot's skill. Radar was utilized in fighter armament control for the first time on a production basis primarily for night combat.

In Korea, the use of jet aircraft increased armament control probblems to a large degree. Greater speeds and altitudes made target acquisition difficult, shortened the available tracking time and increased the need for accurate lead computation. As a result, radar ranging and automatic lead computation became indispensable. It is interesting to note that the designers of the lightweight MIG-15 fighter, contrary to popular belief, found this equipment to be equally indispensable and devoted weight and space equivalent to that incorporated in our heavier, longer range aircraft. Korean experience also dictated the development of highly accurate air-to-surface armament control equipment for close support, interdiction and heavy attack missions.

The speed and altitude of aircraft currently being tested approaches twice that of the aircraft used in Korea. While combat radius has remained approximately constant, mission time has been reduced. With the advent of air-to-air and air-to-surface rockets and guided missiles, intelligence on target position and velocity is required beyond the range of the pilot's physical ability. The performance gains of enemy aircraft while partially offset by advances in weapon technology have reduced the fighter aircraft to a single chance of successful interception, indicating the extreme importance of accurate armament control. Speed increases and the utilization of nuclear warheads have forced the attack aircraft to deliver its weapons from greater standoff distances. Accuracy has become a direct function of the quality of armament control employed. This problem is further increased by the requirement for an all-weather attack capability. Furthermore, to counter this potential in enemy aircraft, fighters must also be equipped with all-weather systems.

The challenge produced by these technological advances has been met by the development of sophisticated armament control systems employing powerful search and track radars, infra-red devices and complex airborne computers capable of operation under the most extreme environmental conditions. These equipments, by supplementing the pilot's basic skills, have vastly increased his capability while freeing him for employing his most unique capability for decision. The future of manned aircraft in weapons delivery is dependent on efficient utilization of the pilot's decision-making ability — no machine developed to date can equal or surpass it.

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climb under the two Westinghouse J40 turbojets, a precision cruise at altitude navigated by the Navaho missile inertial guidance system (shown for the first time in the NAA movies), a mock "dive-in" to target (with possible evasive action) and a recovery by means of a conventional landing under the control of what an NAA spokesman called the first closed loop automatic landing system.

The X-10 also demonstrated that, while the Navaho type missile will be many times slower than the ICBM type missile, it will to a certain degree be able to make up for this in evasive action. Due to its canard control configuration, the X-10 had very rapid control response. Just what means are used in the Navaho type missile to detect and evade enemy interception have not been made known. It was intimated that some of the X-10 flights were actually ended by plunging the X-10 into the ocean in a full simulation of the Navaho terminal dive.

Most of the more than 100 X-10 flights ended with vehicle recovery. Actual Navaho test vehicles will also be recoverable, according to a NAA spokesman.

Also at the exhibit was a 4 ft. wind tunnel model of the Navaho which cost over $300,000.

Russians Describe Nuclear Detectors

Russian aircraft are equipped with manually operated samplers based on the use of paper filters to detect traces of plutonium and uranium-235 in the atmosphere that indicate the location, time and type of nuclear weapon explosion.

Writing in the Soviet publication Science and Life, Dr. M. B. Neiman, a Russian chemist, said that the explosion itself can be detected with a seismograph, but more detailed information can be obtained from aircraft-gathered samples. The article was translated by AVIATION WEEK.

Samplers are located in the wings. The pilot opens a plug on the sampler by means of a lever in the cockpit, and air is drawn through the paper filters, trapping dust particles and fragments of nuclei formed during the explosion.

"When air passes through an alkali solution," Dr. Neiman wrote, "carbon dioxide is absorbed. The carbon dioxide can hold the radioactive carbon-14 formed during the explosion. Then the tritium contained in the sample is burned in a furnace. This forms tritium water, which is condensed in a refrigerator. A more complete separation of the recovered substances and analysis of them is done later in a special laboratory. . . ."

Sergeant for Army

Solid propellant Sergeant tactical missile (AW Oct. 29, p. 25) is being produced by Sperry's Utah Engineering Laboratories, Salt Lake City, Utah, as a replacement for the Army Corporal.

Range of the Sergeant is believed to be approximately that of the Corporal—100 mi. Its handling characteristics in the field should be much simpler, however, than the liquid-propelled Corporal.

Centrifuges Developed For Guidance Testing

Two ultra-precision centrifuges for subjecting critical inertial-type missile guidance system components to simulated operational acceleration forces will be designed and manufactured by Genisco, Inc., Los Angeles. Cost of each centrifuge will be approximately $150,000.

Delivery of the first machine is scheduled for fall.

Centrifuge will operate about two orders of magnitude better than any centrifuge machine previously attempted, according to the company. Full range will be 0.025 to 12Gs with a precision payload, and up to 25Gs with a non-precision payload. A 300 lb. test object will be accommodated.

Design will include temperature and strain compensation to maintain critical radius under dynamic conditions, special rotor bearings under fluid pressure to maintain extremely close concentricity, special 36-in.-diameter differential synchronous motor developed by Genisco for wide-range speed control, and hydraulic torque-booster motor.

North American Given Titan Ground Contract

Los Angeles—Transtainer units, large aluminum trailer-type bodies to transport the Titan intercontinental ballistic missile, will be built by North American Aviation's Los Angeles Division under subcontract from the Martin Co.

The units also will be used as containers for the Titan on the ground.

Stanford Will Analyze Army Missile Production

Stanford Research Institute of Menlo Park, Calif., will analyze production of Army operational missiles, including the anti-aircraft Nike Hercules and the anti-tank Dart under a $97,000 Army contract.

Objective of the overall study is to provide standard analytic methods for cost schedule and budget control over missile system programs.

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LG 14

Martin Denver Integrates Titan Needs

By George L. Christian

Denver—One of the newest facilities to be erected specifically for the production of very large missiles—in this case the Titan intercontinental ballistic missile—is busy with activity in a remote, rugged location 20 miles southwest of Denver.

The Martin Company's Denver Division, is unique because it integrates in a single tightly knit entity and in one geographical location all the requirements for producing an ICBM.

Under one roof, Martin has built the necessary, specialized physical plant and has gathered all the required engineering, manufacturing, laboratory and test facilities and trained personnel to conceive, design, build and production test the Titan, plus fuel and static fire the missile at full thrust.

Missile Contracts

Titan is being built under a $358-million Air Force contract. Other USAF ballistic missile definite contracts that have been announced are: Convair Atlas—$145 million; Douglas Thor—$67½ million.

What kind of a plant should be designed to create and manufacture an ICBM?

Here are the opinions expressed to AVIATION WEEK by Charles Williams, in charge of all missile testing and servicing, and Robert Swope, who heads up the master planning department.

They feel that their plant, which is in the late stages of completion, is completely equipped to cope with and has thoroughly co-ordinated every function related to the creation of Titan. As a result, Martin hopes to slice research and development time and cost of the missile. Also, "factory quality control" of each piece, component and system of the ICBM will be guaranteed by Martin's insistance on tightly fusing its manufacturing and testing processes.

Large Tanks

Manufacturing an ICBM means building large tanks to hold the enormous quantities of fuel the weapon needs to achieve long range. Empty weight of ICBMs like the Titan is only 10% or less of its total takeoff weight—the difference is made up by fuel.

When the Denver Division was laid out, it became immediately apparent that, while an airframe factory could be converted to build missiles without undue difficulty, the reverse is not true.

Reasons are:

- **Vast expanse** of floor space and high bay areas to clear lofty tail assemblies are not required.
- **Individual components** take on linear

MARTIN'S Titan plant near Denver (above). Engineering/administration building is at left, missile factory center. Note rectangular exit door from final assembly at right.

NEW ENGINEERING laboratory (above) and static missile test stand (below) being erected on Titan plant site. Size of test stand can be judged by two men standing on structure.

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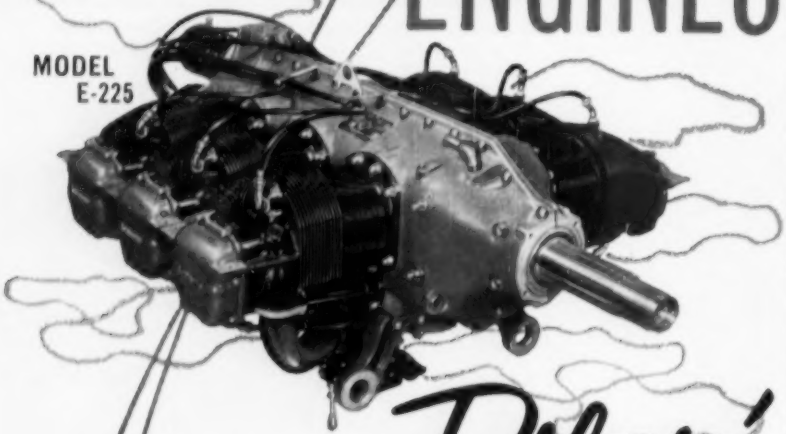

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O-470-K & L	230	2600	6	438	80
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characteristics and move down long, narrow fabrication lines.

• **Few, relatively** large parts characterize manufacturing process of big missiles, contrasted with the many small and detailed bits and pieces needed for a conventional airframe. Result is simplification of materials handling and store keeping chores.

Large, specialized tools for specific jobs are required to make ICBMs. For example, Denver division's welding equipment had to be specifically designed to handle components larger than those which it was originally intended to handle.

Martin laid out its production machine shop to include a relatively new production method—chemical milling. Process was developed by North American Aviation's Missile Development Division. The method chemically removes metal which normally would be hogged or milled out to form a part.

The plant does not handle or use any so called exotic materials.

As a Martin spokesman said, "Our plant here was erected to build large missiles. We could build missiles bigger than the Titan without much modification to the plant or to the tooling. But if we were required to shift production to planes, major modifications to plant and machinery would be required."

Desirable Denver

Reasons for Martin's selection of a site near Denver for its ICBM plant are:

• **Large chunk** (7,000 acres) of land was available, and it was well isolated so that rocket motor noise would not bother anybody. Mountains protect the site from the west, ranches and National Forests adjoin on the other three sides. Nearest populated area, Littleton, a Denver suburb, is 10 miles east of the plant.

• **Denver,** although remotely located from other large towns, is a metropolis of almost a million population. It is the hub of the Rocky Mountain area with attendent communications network, transportation, cultural, shopping and other facilities.

• **Excellent educational** institutions are grouped around Denver.

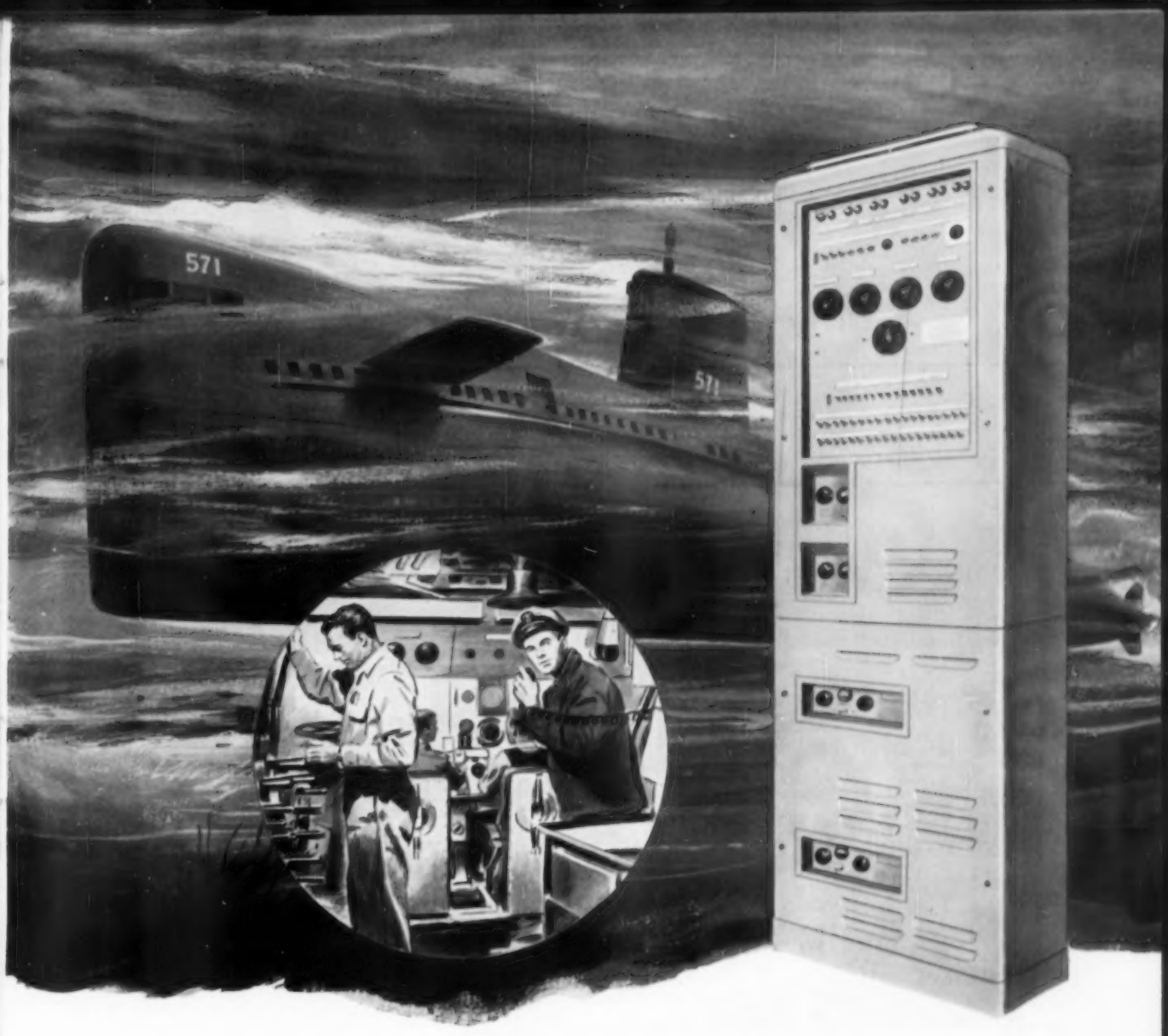
• **Colorado** is an attractive vacation land, making it easy to attract personnel to Denver.

• **Fuel, gas,** electricity and water were available in ample supply.

• **Area selected** affords the maximum security essential to the work at hand.

• **State and county** agencies and the Chamber of Commerce were very encouraging and co-operative.

These are the reasons why Martin management selected Denver for Titan construction after making an exhaustive survey of possible locations which cov-



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ered 94 cities in a 33 state area.

The Titan factory is a contemporary, windowless structure 612 ft. long, 246 ft. wide and 70 ft. high. Lower level is made of concrete block, upper level of aluminum panels. It is built longside-to into a slope so that materials are received on the lower level, and finished Titans roll out of the opposite end on the upper level. Detail parts are made on the lower level, then moved to the upper level where the missile will be assembled.

Instead of the high and wide hanger doors of an aircraft factory, a medium size, rectangular opening at the end of the plant will serve to bring the Titan outside.

From the factory, the Titan will move to a new vertical test fixture now under construction. Here it will undergo complete test of all its systems, including the motions of pre-flight and launching, but not actual fueling and firing. Result will be strict quality control of all the highly complicated components and system within the missile.

Sample quantities of production missiles will be taken to the adjacent firing area, fueled and static-fired. This is necessary to make sure the intricate firing systems operate correctly.

Also in the new building will be a general laboratory plus a specialized cold flow or cryogenics laboratory.

Captive Test Firing

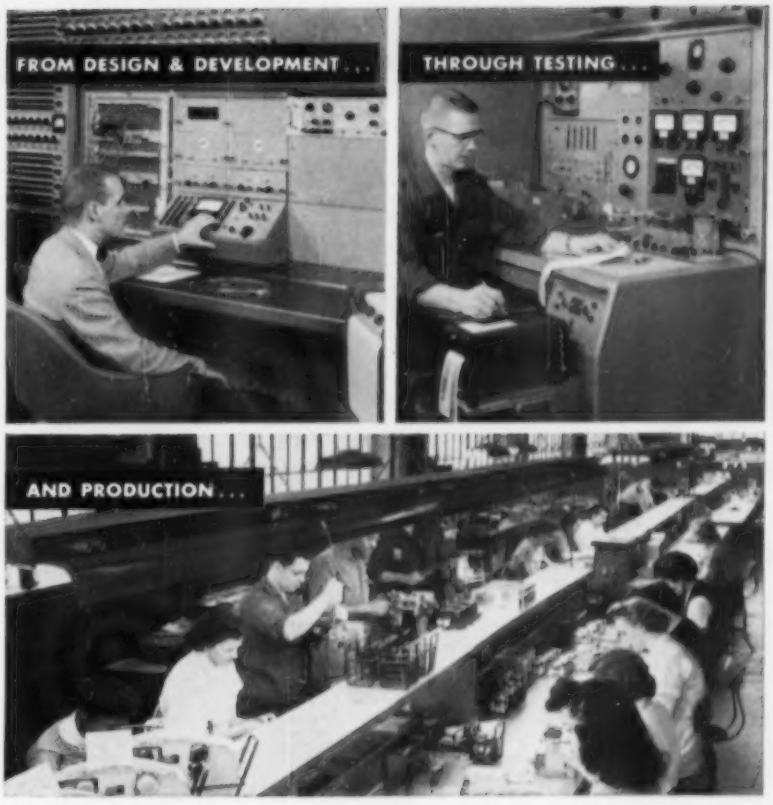
An uncompleted captive test firing facility is nestled into the foothills near the main Titan plant. Test stands are so arranged that any one may be fired without danger to technicians who might be working at any of the others.

Two control buildings handle a pair of test stands each. Concrete tunnels, measuring about 4 x 7 ft., connect control buildings with their respective test stands. Tunnels are used to run control and instrument wiring between test stand and control room, thus making the wiring readily accessible to check, change and repair if necessary. Tunnels also give weather protection for test personnel walking between control buildings and test stands. Serving all test and control facilities are two parallel high pressure lines, each about four miles long carrying nitrogen under 5,000 psi. pressure. Nitrogen is used as a pneumatic power source in the control areas because it is reliable and its non-sparking, non-heating and inert characteristics make it very safe to use.

Huge water storage facilities are located on the crests of hills above the firing stands to provide water to cool blast deflectors with flows up to 30,000 gal./min. per deflector.

Firing facilities are nearing completion, and construction gangs are gradually being moved out.

Many problems associated with build-



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G. D. Schott (center), Flight Controls Department head, discusses a rocket control system with Group Engineer R. A. Fay (right) and F. G. Hudson, missile components research specialist.

FLIGHT CONTROLS THEORY

The transition from theory to reliable components is one of the most difficult phases of flight controls endeavor. At Lockheed Missile Systems Division, engineers and scientists are performing advanced work on a number of theoretical approaches that offer important practical solutions.

Two of the areas are:

- Utilization of feed-back design techniques for optimizing complex dynamic systems
- System verification by analog computer simulation

Significant developments in these and related areas have created new positions on the Staffs at Palo Alto, Sunnyvale and Van Nuys. The complex nature of the assignments requires both flight controls experience and the ability to exercise individual initiative. Inquiries are invited. Please address the Research and Development Staff, Sunnyvale 31, California.

Lockheed **MISSILE SYSTEMS DIVISION**

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ing and controlling large, long-range missiles cannot be solved by looking to manned aircraft for a precedent.

Example is the use of redundant systems in aircraft to obtain reliability. Multiple communications sets are carried, hydraulic and other systems are repeated in essential tasks, structure is redundant in critical areas. And a man is there to "compute" when to throw the switch to move from one system to another in case of failure.

Missiles have no room or weight capacity for redundancy. There is only one of everything. Absolute dependance is placed on each individual missile piece and part. If one fails the whole multi-million dollar project may be wasted.

One problem is that components must operate in environments in which the elements are unknown. Procedure to solve the problem is to estimate the environment as accurately as possible, test the component in this environment under simulated conditions, and get it to work there. Then the missile is fired into the environment to see how close the estimate of its performance was, and components are then revised to operate under the actual environment as it is determined.

Questions daily facing missile makers:

- **How to avoid** interaction between two or more tightly packed systems from disturbing their functioning?
- **Are the many materials** used in a given system perfectly compatible with one another, or will an incompatability develop which will cause a malfunction?
- **How can every** last ounce of efficiency be squeezed out of a device required to perform with the highest order of reliability?
- **How is the paradox** solved of requiring this very high order of reliability of a component which is given a very low margin of strength?

High Obsolescence Rate

An overall problem with missiles is their high rate of obsolescence. Reason is that they are much more specifically oriented to a given mission than an airplane is. And they are cut much more closely to their performance margin.

Missiles are tailored to do a specific job—there is no such thing as an all-purpose missile.

Shelf life, or old age is no problem. Missile stockpiles can be maintained and kept in operational readiness. But system obsolescence is a hardening of the arteries that no one can yet lick.

To date, the Martin Company has invested $12½ million of its own money in Denver Division. The test facilities are paid for by the government.

Although the division only began occupancy of the engineering and administration buildings last December 3 and factory operations started on February 4 of this year, Martin already has 2,500 employes busy designing and building the Titan. By next year, Martin expects to double employment to 5,000.

Speed of the facility's construction is shown by the fact that ground was broken on February 6, 1956—so occupancy was possible in less than one year. Already a $2 million expansion is under way involving three new structures totalling over 160,000 sq. ft. in area.

Included are:

- **Engineering Laboratory**, of prefabricated steel design, which will be equipped to check out the Titan's entire network of control and other systems with the ICBM in flight (vertical) attitude. Building will also provide permanent space for operations now housed in interim facilities in Denver. The 240 x 340 ft. laboratory being erected separately from but near the main factory, was scheduled for completion last month.
- **Engineering-administration** building will be extended 67,000 sq. ft. by adding a wing on the south side of the present building.
- **Cafeteria is being** expanded by 12,000 ft. with a second floor addition.

To speed transportation between the plant and Denver's Stapleton Field, located on the opposite side of the city, the company will build a heliport adjacent to facility and establish a helicopter shuttle over the 30 mi. route.

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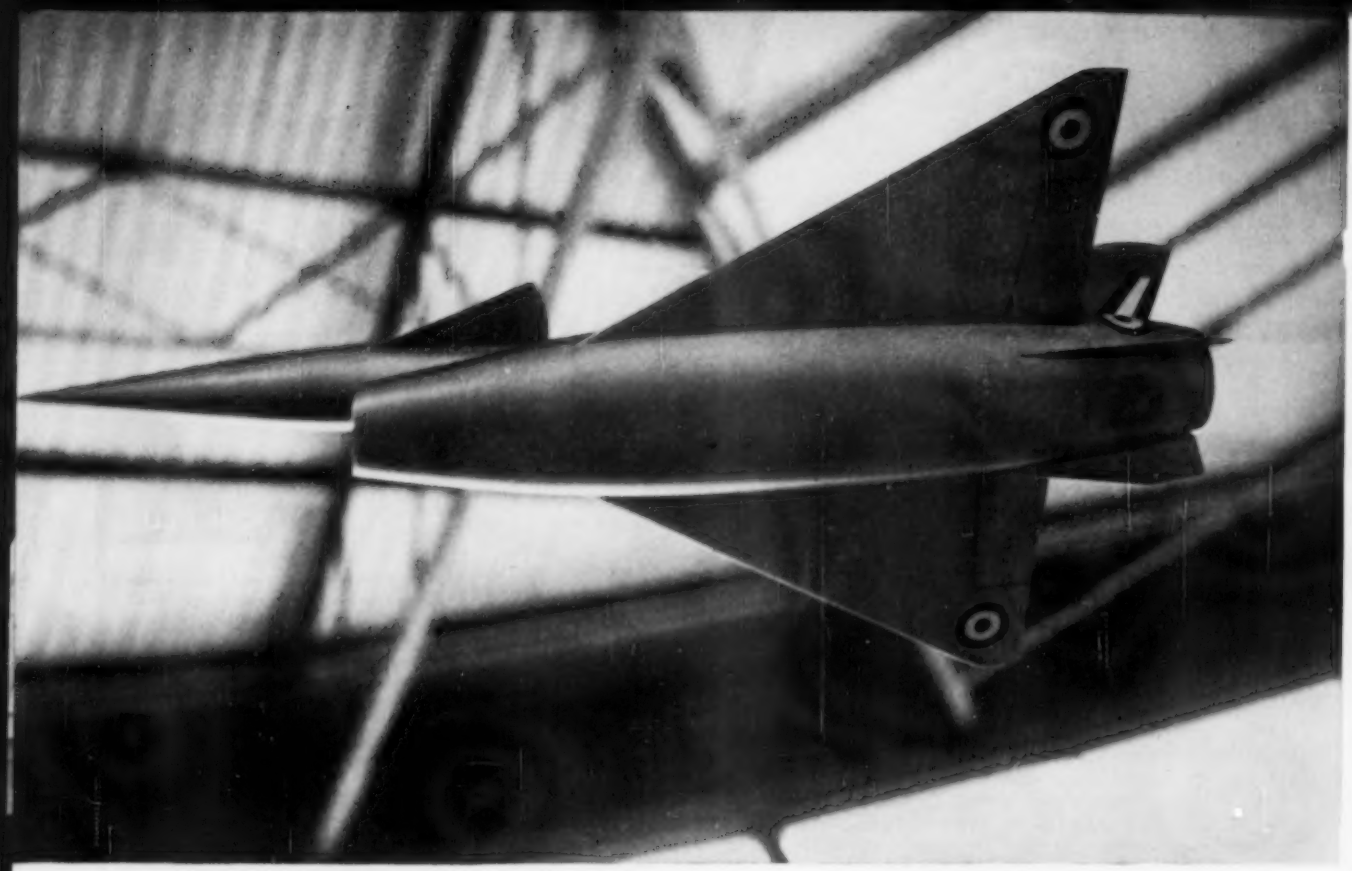
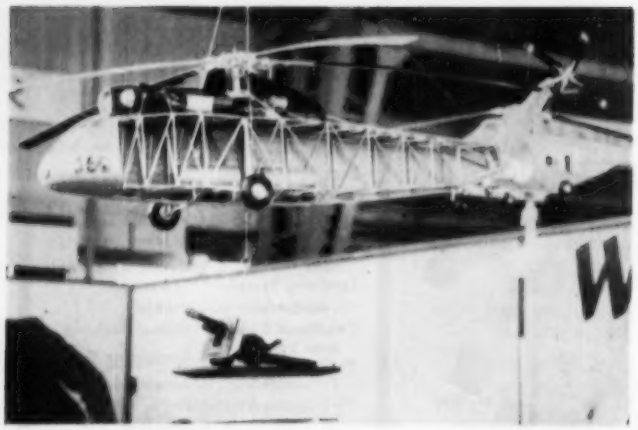
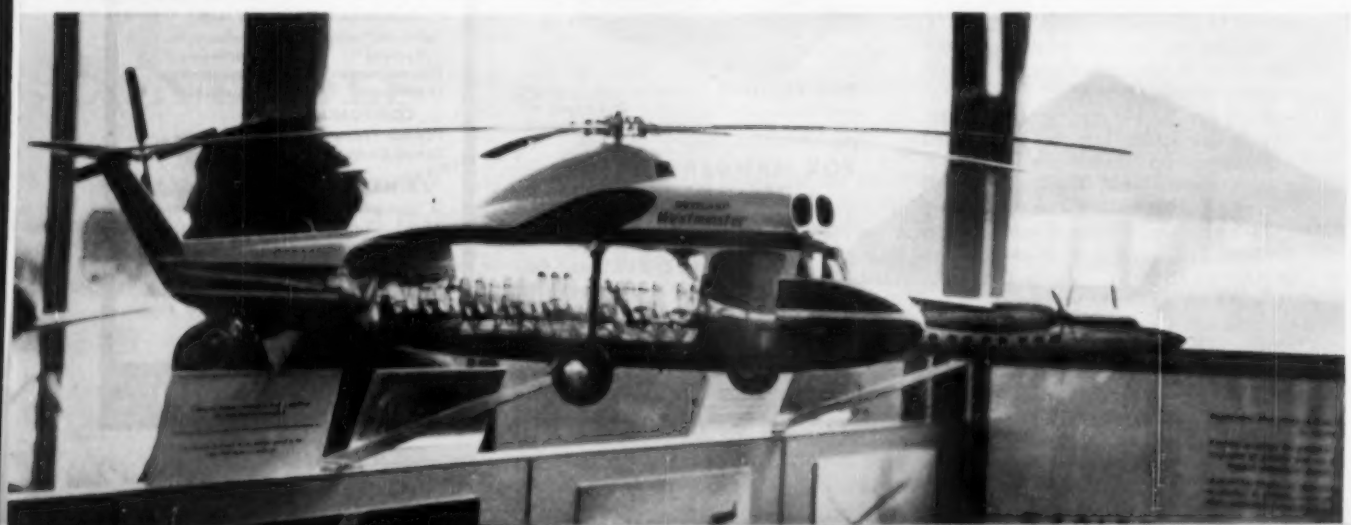




NORD 1500 "Griffon" model shows the unique canard lay out of this experimental supersonic delta-winged interceptor. Powerplant is a Snecma Atar E incorporated into a turbojet ramjet combination. Note inboard elevons, ventral strakes for highspeed, high angle of attack stability.

WESTLAND WESTMINSTER helicopter models show the basic similarity to the Sikorsky S-56 layout. Westminster is powered by a pair of Napier Eland gas turbines. Trusswork model (left) is of first prototype and also shows proposed utility version; enclosed model (below) shows proposed seating arrangement for troop-carrying or passenger service.



DASSAULT Etendard IV light fighter designed to NATO requirements is shown in modeled tactical base. Note ground vehicles under trees in background.

European Trends in Design, Tactical Use Shown by Models

Paris—Models of new aircraft proposals, plus dioramas showing tactical deployment of current types, provided one of the major highlights of the static displays at the 22nd International Aeronautical Salon at Le Bourget.

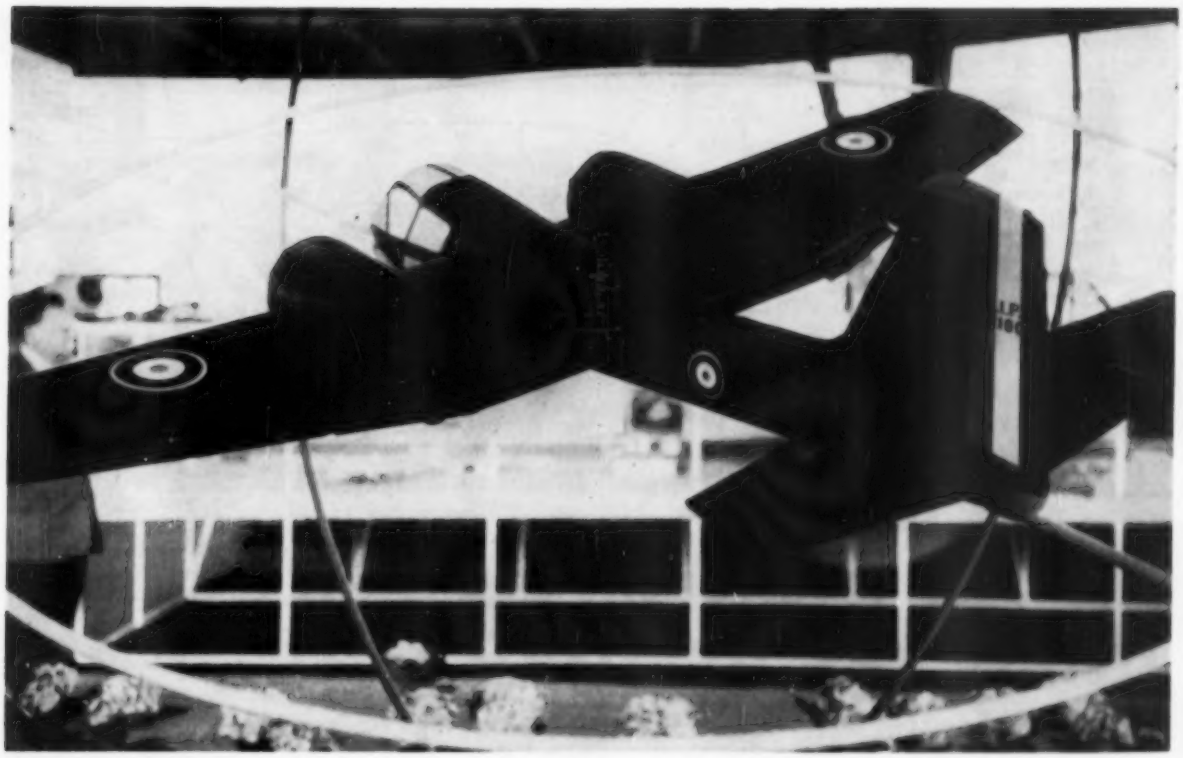
Rival French firms of Sud Aviation and Generale Aeronautique Marcel Dassault made the biggest effort with huge displays modeling down to the last detail the proposed tactical bases and support for the Trident and the Etendard respectively. Trident diorama had running commentary simulating a complete intercept of enemy aircraft including the use of models suspended beneath a blue dome over the field to illustrate the attack with guided missiles.

Shown for the first time in detailed model form were the Fairey airborne early warning version of the Gannet anti-submarine craft, the Westland Westminster helicopters powered by twin Napier Eland gas turbines, and Piaggio seaplanes for passenger transport, air-sea rescue and anti-submarine duties.

POLISH transport due in production "next year" according to its promoters, is a four-engined proposal with a cabin layout for 21-28 passengers.

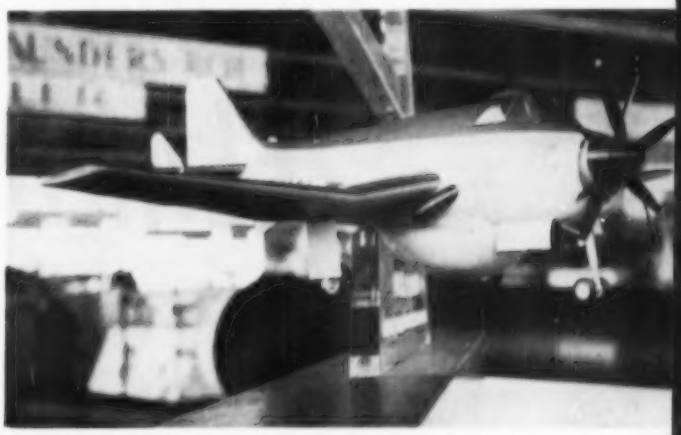
PIAGGIO P.155 is proposal for turboprop-powered anti-submarine aircraft. Hull features extremely high length-beam ratio and single step. Other models of same design showed a passenger transport and an air-sea rescue version.

SUD AVIATION Trident rocket-plus-turbojet interceptors are modeled as they would be deployed at an unimproved airbase. Note the camouflaged hangars, trucks for servicing.

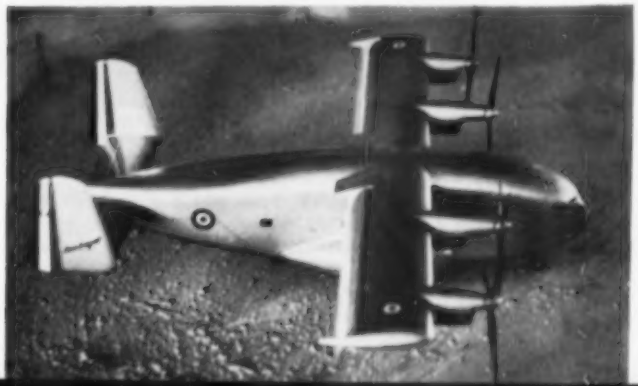


SIPA 1100 is proposed photo-reconnaissance and ground attack design. Powerplants are Pratt & Whitney R1340s rated at 610 hp. each. Note resemblance to Grumman high-performance observation aircraft design for Army and Marine Corps (AW May 27, p. 28).

TENTS FOR SERVICING also were shown in Sud diorama. Note truck which is towing Trident to flight strip.



BREGUET 941 (below) is STOL design now under development (AW May 20, p. 29) using four General Electric T58 turboprop engines and a full-span flap. Fairey airborne early warning design (above) shows latest version of this naval turboprop-powered craft. Changes include belly radome and new arrangement for crew.



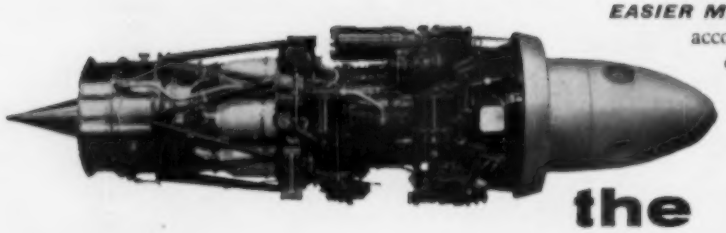
Larger payloads – Longer hauls with ELAND

Years of progressive research on compressor and turbine design have produced the advanced aero-engine techniques which give Napier engines long life, high performance and low operating costs.

But the case for the Eland is not based on ground test performance alone. These facts and figures are taken from the flight performance of a typical medium-haul aircraft, the Convair 340, converted from piston to Eland.

FASTER AND FURTHER Larger payloads . . . longer distances. With the Eland the Convair operates at its design all-up weight of 53,200 lb. as against 47,000 lb. with piston engines, and can carry its maximum payload of 12,880 lb. a distance of 1,220 miles as against 290 miles, with an increase of cruising speed up to 55 m.p.h.

EASIER MAINTENANCE With engine maintenance accounting for some 20% of an airline's direct operating costs, the Eland's single-spool design



the era of the

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assumes a special importance. As a result of developing the highest stage-loadings ever achieved, it has been possible to avoid the complexities of the twin-spool. Reduction gear assembly, compressor assembly, main support plate and combustion chamber assembly and turbine unit are designed as independent power sections each of which can be removed quickly and replaced as required. The metering control unit is a self-contained rig-tested assembly which can be replaced with only minor adjustments to the engine link work. This unit construction allows maximum life to be obtained from each component with consequent savings in overhaul costs.

GREATER SAFETY Because of its simplicity the Eland is inherently safe. There is no surge and in the event of any mechanical failure between engine and gearbox the overspeed governor continues to be driven by the engine, thus preventing any overspeeding. The oil system pumps (driven by the propeller) continue to supply oil to operate the autopitch coarsening.

LONGER FUTURE It is now generally admitted that the recent decision of some of the world's leading airlines to invest in turbo-prop is in fact the logical decision that will have to be made sooner or later by all middle-haul airlines. Of turbo-prop investments the Eland will pay among the safest dividends. The Eland conversion means virtually *a new aircraft* at one third of the price and it is a relatively simple and speedy operation to put the new higher-revenue-earning aircraft back into operation in the minimum of time.

HIGHER PROFITS It has been estimated that a Convair 340 conversion operating over stage lengths of 200 miles with a utilisation of 3,000 hours per year and a load factor of only 65% would show a profit increase of $100,800 per year over the piston engine version. On routes with stage lengths of 800 miles a fleet of 20 Eland Convairs in similar conditions would show more than $3,000,000 extra profit annually.

The trend of the efficient airline is towards the propeller turbine; the right decision now will mean high operational success in the next decade.

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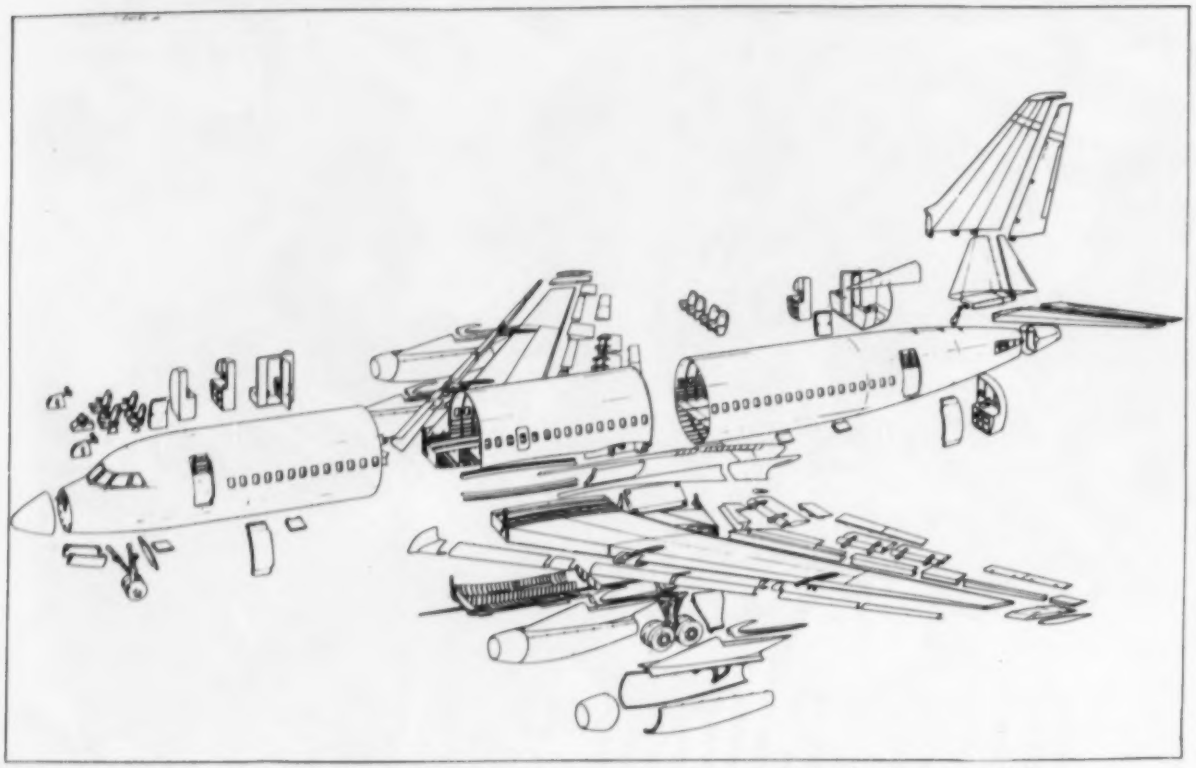
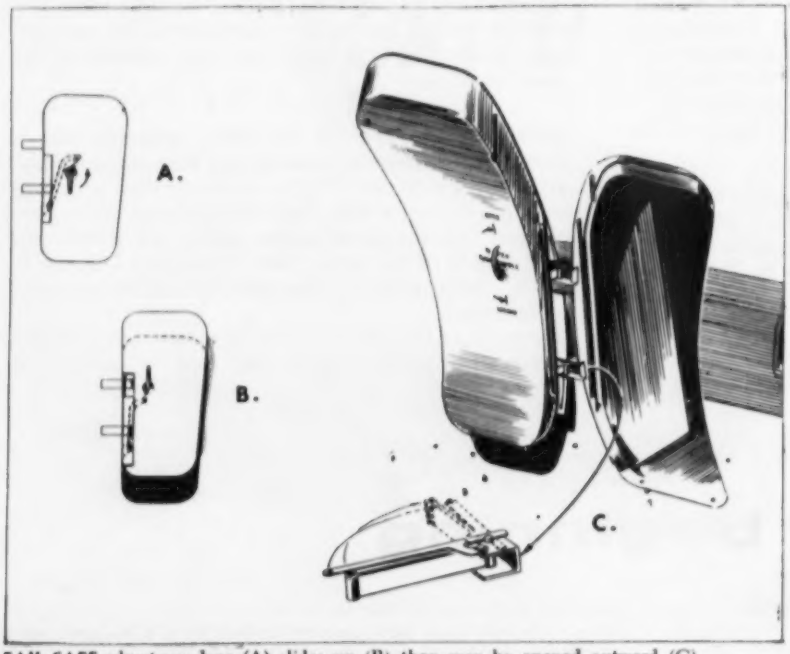


BREAKDOWN of Convair 880 jet transport shows major sections of airplane structure. Each cabin bay has one window.

Heavy Skin, Fail-safe Features Mark 880



FAIL-SAFE plug-type door (A) slides up (B) then may be opened outward (C).

By Irving Stone

San Diego—In the engineering of its 880 jet transport, Convair Division of General Dynamics Corp. has insured added protection against explosive decompression by increasing the gage of fuselage skin beyond normal practice.

Convair's engineering philosophy in this approach has been to substitute skin weight for acoustical tape, along with elimination of stringers over a considerable area and minimization of stringer size where these units are used.

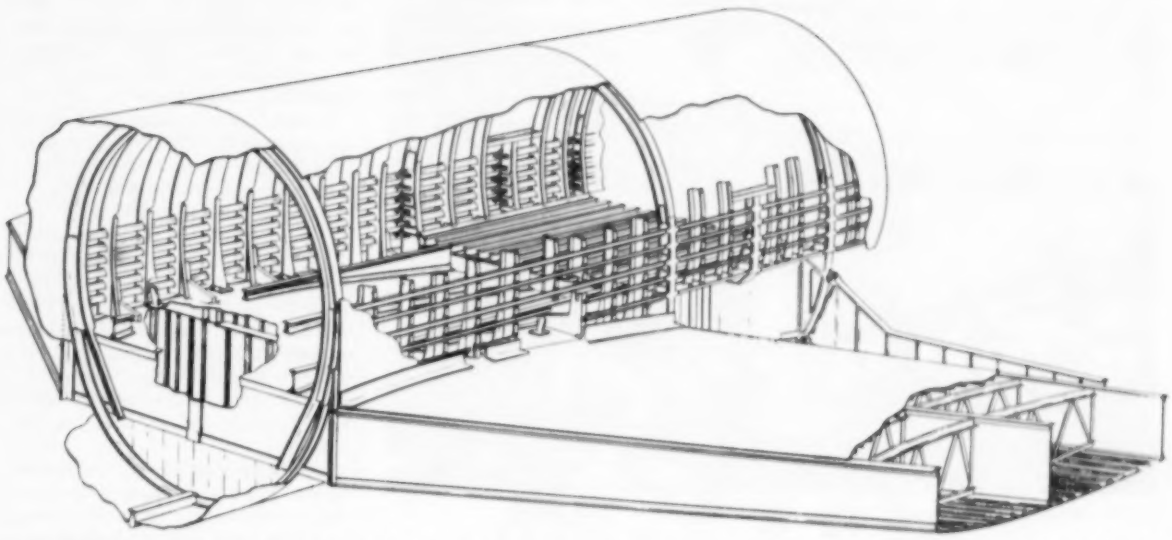
Sound Effect

Net effect, Convair structural engineers say, is equivalent sound attenuation coupled with lower pressurization-induced stresses, with no significant weight increase.

Backing this heavier skin gage, Convair has used fail-safe features throughout the fuselage, and in the wing.

Analysis of the 880 design reveals the following structural highlights:

Fuselage skin is 2024-T3 for superior resistance to crack propagation, with gage ranging from .063, generally in



CONVAIR 880 wing and fuselage mate point details. Note three-spar construction of wing. Aircraft will use integral fuel tanks, Scotch-weld bonded for extra strength and reduced maintenance. No fuselage fuel will be carried in standard version.

locations below the floor line, to .100 above floor and aft of wing rear spar. Gage grades down to .071 going forward from rear spar.

Minimum skin gage results in a maximum gross hoop tension stress of 8,460 psi. at 8.2 psi. cabin pressure. This compares with 9,400 psi. on the Convair 440 and with higher stresses on most current aircraft, Convair engineers claim.

Tension Stress

Generally, stringers are $\frac{7}{8}$-in. extruded 7075-T6 Z-sections. At area of greatest fuselage radius, approximately centered on the floor line, stringers are 2024-T3 and spacing is about 6 in. Below this region, spacing is 9 in., except in areas fore and aft of the wing, where extra stringers are added between the 9-in. spacing.

Above greatest radius area, stringers are eliminated up to a point varying from approximately 15 to 40 in. from top centerline. Width of stringer installation in this top area is greatest over the wing.

Fuselage Frames

Fuselage frames are stretch-formed 7075-T6 Z-sections. Typical frame is $3\frac{1}{4}$ in. deep and .050 gage. Typical stringer also is .050 gage.

Window size is approximately 9 by $12\frac{1}{2}$ in. One window for each cabin bay affords two windows per seat row on each side.

Window frames are single-piece aluminum alloy forgings. Heavy skin supplies sufficient support for the window frames and climinates need for longerons to tie into the beltframes.

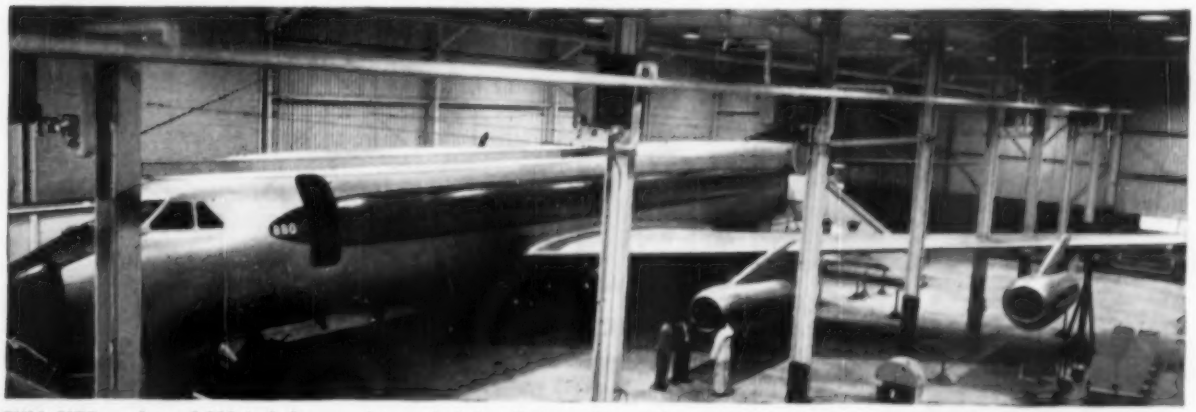
Window itself consists of 3 panes of stretched Plexiglas 55. Total glazing weight was selected to give adequate sound attenuation, but any single pane will take the full load. Outer installation consists of two panes separated from each other but fabricated as a unit. Single inner pane is rubber mounted to give effect of a floating panel, which promotes sound attenuation.

Cabin floor is an aluminum alloy sandwich, supported by transverse floor beams at each frame. There are no vertical members to support these floor beams, giving a more resilient belly structure for wheels-up (forced) landing. Presence of verticals might transmit shock to the cabin floor structure, and actual wheels-up landings with other transports have justified this viewpoint, Convair engineers say.

Windshield Glazing

Cockpit enclosure is designed so that complete failure of any one of the windshield posts will not precipitate general failure of the enclosure. Windshield glazing is glass and vinyl sandwich, with three panes of glass and two of vinyl. Outer windshield pane is a Nesa unit.

Door design for pressurized high alti-



FULL-SIZE mockup of 880 includes complete cockpit installation. Convair has used fail-safe features throughout.

WING JIG used in construction of Convair 880.

tude jet transports has received considerable attention to minimize danger of door blowout and sealing leakage. Convair's approach for the 880 has been to use a wedge-shaped door narrowing towards the bottom. Left and right sides have tongues which engage door jamb grooves so that, in effect, the door is larger than the opening.

For opening, 180-deg. swing of the handle slides the door upwards on slotted tracks, disengaging contact between tongue and groove, so door can be swung outward. During opening, no part of door moves into the cabin, and door can be opened even though passengers might be pressing against it. When closed, door is flush with inside and outside cabin surfaces.

There are no hinges or protuberances in the cabin. Rubber sealing, similar to that used on Metropolitan 440, expanded by cabin pressure provides an airtight periphery. Same configuration is applicable to both passenger (two) and service (two) doors.

Frames surrounding door openings are composed of multiple members so that failure of any one member will not result in failure of the frame.

Aft pressure-bulkhead in fuselage is located forward of the horizontal tail because this surface is adjustable, hence would introduce sealing problems.

At the plane of symmetry on fuselage bottom a heavy built-up keel member insures structural continuity in the region where the normal shell structure is interrupted by the wheel well and, to a lesser extent, by the wing center section.

Under-fuselage compartmentation aft of the weather-mapping radar nose includes, successively, the nose wheel well, electronic and electrical sections, forward cargo area, air conditioning system (under wing center section), main landing gear well, hydraulic-pneumatic section, and rear cargo compartment.

Wing sweep is 35 deg. at 30% chord. Primary structure is a box-beam plate-stringer type. Skins are roll-tapered, varying generally between .08 outboard, to a maximum of .25 at the breakpoint, where the wing trailing edge

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Convair 880 Data

WING:	
Area (basic)	2,000 sq. ft.
Aspect ratio	7
Airfoil thickness ratio	
9.75% span	10.55%
31.51% span	9.00%
64.70% span	8.514%
Tip	8.00%
Sweepback	35 deg. @ 30% chord
Taper ratio	0.25
Dihedral	7 deg. in mfg. chord plane
HORIZONTAIL TAIL:	
Area	395 sq. ft.
Aspect ratio	3.8
Air foil thickness ratio	
Root	9.5%
Tip	8%
Dihedral	7 deg. 30 min.
Sweepback	35 deg. @ 30% chord
Taper ratio	0.285
VERTICAL TAIL:	
Area	295 sq. ft.
Aspect ratio	1.518
Airfoil thickness ratio	
Root	10%
Tip	8%
Sweepback	35 deg. @ 30% chord
Taper ratio	0.33

sweep terminates. Stringers are extruded Z- and J-sections (Z with one flange extended). Some stringers are machined for taper.

Bottom Wing Structure

Bottom skin, stringers and spar rails are 2024-T3 material. This was selected for the bottom wing structure because of its better resistance to fatigue and crack propagation. Aeroelastic effects of the swept wing are such that ultimate strength requirement is relatively less critical than fatigue requirements, hence the 2024-T3 material could be used without weight penalty, Convair engineers claim.

Upper wing skin is 7075-T6. Stringers and upper spar caps are 7178-T6, except that front spar cap is 2024-T3, chosen because contour of wing gave relatively low front-spar stresses and ductility of the material affords good resistance to forward-acting fuel loads in the integral tank, in the event of sudden deceleration.

From wing root to a point outboard of the outboard engine, a three-spar arrangement is used—front, middle and rear spars—exclusive of the auxiliary spar which partially supports main landing gear. Purpose of this arrangement is to provide a failsafe structure in the event any one of the three spar webs should fail. Also, the middle spar affords an intermediate support for wing bulkheads, particularly advantageous in relatively thin wings.

Outboard of the outer engine, only two spars are used in the box beam. Fail-safe integrity is maintained by unbroken leading edge and trailing edge sections (aileron is located just outboard of inboard engine).

Each wing accommodates four integral tanks. Two are located one behind the other inboard of the inboard engine pod. Third tank covers approximately the space between engine pods. Fourth tank includes the remainder of the wing outboard of the outer pod.

Tank Sealant

Tank uses Minnesota Mining & Mfg. Co.'s Scotchweld system (primer and tape) for sealing. This is same system used on Convair's F-102, and has shown no leaks in this interceptor, but Convair will conduct extensive tests to investigate effects of 880 wing flexure on the sealant.

Structure is designed assuming no strength benefit from the Scotchweld sealant, but tests show considerable benefit to fatigue life of joints and splices made with Scotchweld in addition to riveting. Scotchweld primer provides corrosion resistance, Convair claims.

Main landing gear is supported by wing box beam rear spar and auxiliary spar aft of this member. Auxiliary spar is supported jointly by fuselage and

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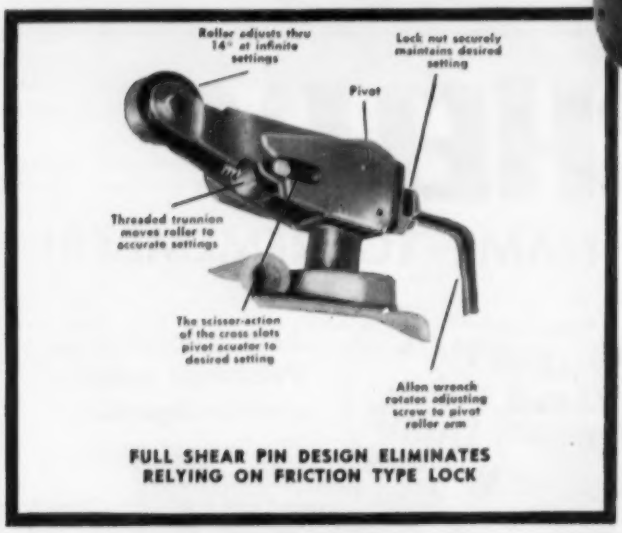
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CHARACTERISTICS

Contact arrangements	H1-58—DPDT, 4 circuit H1-43—DPDT
Pretravel	100 ± .031 adj. fully closed
Movement differential	.062 + .025 adj. fully closed −.000
Overtravel	281 min.
Operating force	4 lbs. + 2, −0
Overtravel force	11 lbs. ± 3
Dielectric strength	1000 V. R.M.S. min.
Ambient temperature range	−100° to + 250° F.
Min. mechanical cycles	200,000
Min. electrical cycles	200,000
Electrical rating	10 amps @ 125/250 V a-c 28 V d-c ind.
Difference of operating and reset point between each pole	.010 max.
Weight	8 oz. max.

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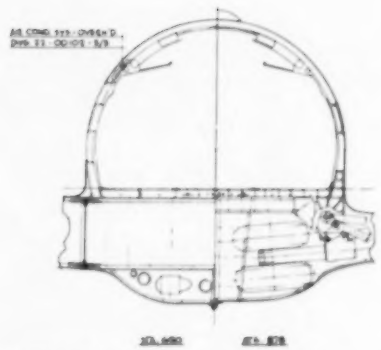

FUSELAGE section shows landing gear wheel well (right) aft of rear spar.

wing structure. Detail design of the local structure is intended to permit landing gear to break away without rupturing the integral wing tank in event of crash landing.

Similarly, attachment of engine pods to wing structure has been designed so that in a wheels-up landing, pod and pylon will break free of the wing without rupturing integral fuel tanks.

Inboard pod pylon and corresponding wing structure is designed to withstand, without failure, a wheels-up landing with a load factor of two at maximum landing weight.

Engine pod intake lip is stainless steel to accommodate hot air for anti-icing. Aft of the intake, for about 40 in., aluminum alloy is used. Remainder of the pod is titanium.

Pylon-to-engine fitting is a steel forging. Pylon-to-wing attachment consists of a single fitting at wing leading edge, two fittings at front spar and, for the inboard engine, a single fitting on the center spar, while outboard engine has a single fitting at the rear spar.

Wing Anti-Icer

Wing leading edge has two thicknesses of skin—heavy gage outer skin and thin inner skin. Inner surface of outer skin is chemically milled to provide recesses for passage of hot air for anti-icing. Lands between recesses provide for attachment of inner skin and nose ribs.

Trailing edge structure, including flaps and ailerons, incorporates aluminum alloy sandwich construction for maximum resistance to acoustical damage from jet blast.

Wing center section, beneath fuselage, incorporates four transverse beams between front and rear spars. Each of these beams has a bolted connection to the fuselage frame directly above it. Failure of any one of these beams or attaching frames will result in a relatively minor loss of strength, and fail-safe character of the structure is adequately maintained in this area.

Adjustable horizontal stabilizer is a

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In close harness with manufacturers, George Jalonick works to further improve his "services of supply" to airlines and overhaul firms. At immediate right, Sales Mgr. Don Morse of Bendix Scintilla (standing, left) joins him to check SAC's Scintilla inventory records. The other photo shows Jalonick receiving the Dallas Jaycee Wright Brothers Medal for community achievement.
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two-spar box structure passing through a cutout in the fuselage tailcone, so that the box is complete from tip to tip.

Leading edge is electrically heated for combating icing. Outer surface is thin stainless steel, inner skin is aluminum alloy, with wires embedded in plastic between these two sheets.

Vertical stabilizer incorporates a three-spar box. Upper section uses skin and stringers to carry bending loads. Loads are transmitted through heavy forged fittings to fuselage frames at front and rear spars and to the fuselage pressure bulkhead at the center spar. Tip of the vertical surface is isolated by a band of plastic to allow use as antenna.

Convair is conducting tests on major segments of wing and fuselage, particularly to establish fatigue-resistance and fail-safe characteristics of the 880 design.

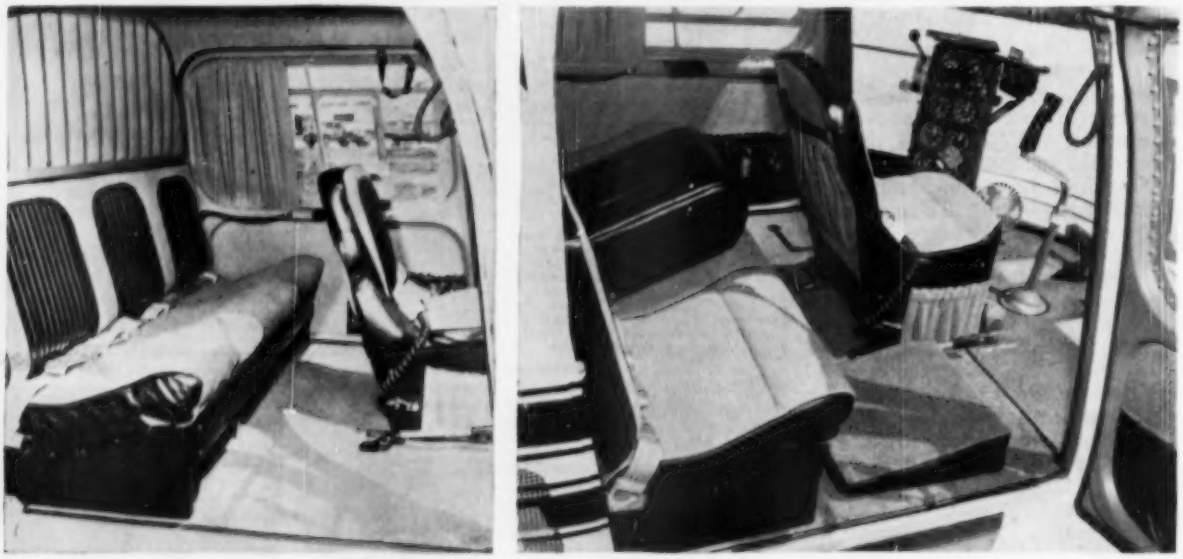
Thus far, Structural Test Section has completed trials on two large sections of the lower wing surface—an uninterrupted plate-stringer panel and another similar panel incorporating an access door.

Uninterrupted panel has withstood cycling equivalent to over eight times that expected in the anticipated service life of the aircraft (50,000 hr.), without any cracks appearing, Convair engineers report.

Panel with the door has withstood cycling equivalent to five times the service life before cracks appeared in the door doubler.

Tests have been completed on three specimens representing a fuselage section below the floor beams. Tests made with both water and air demonstrated that there was no significant difference in using either of these mediums for simulating pressurization loads.

Object of the tests was to demonstrate fail-safe characteristics. Beltframe was severed and a 2-in. sawcut made in the relatively thick (.063) skin directly over the frame. Internal pressurization loads were applied 500 times, with no cracks starting from the sawcut. Increasing the sawcut to 3 in. and repeating the 500 cycles still resulted in no crack propagation. With a 4-in. sawcut, two cracks started after 100 applications of internal pressure. Testing was continued to 3,500 cycles, at



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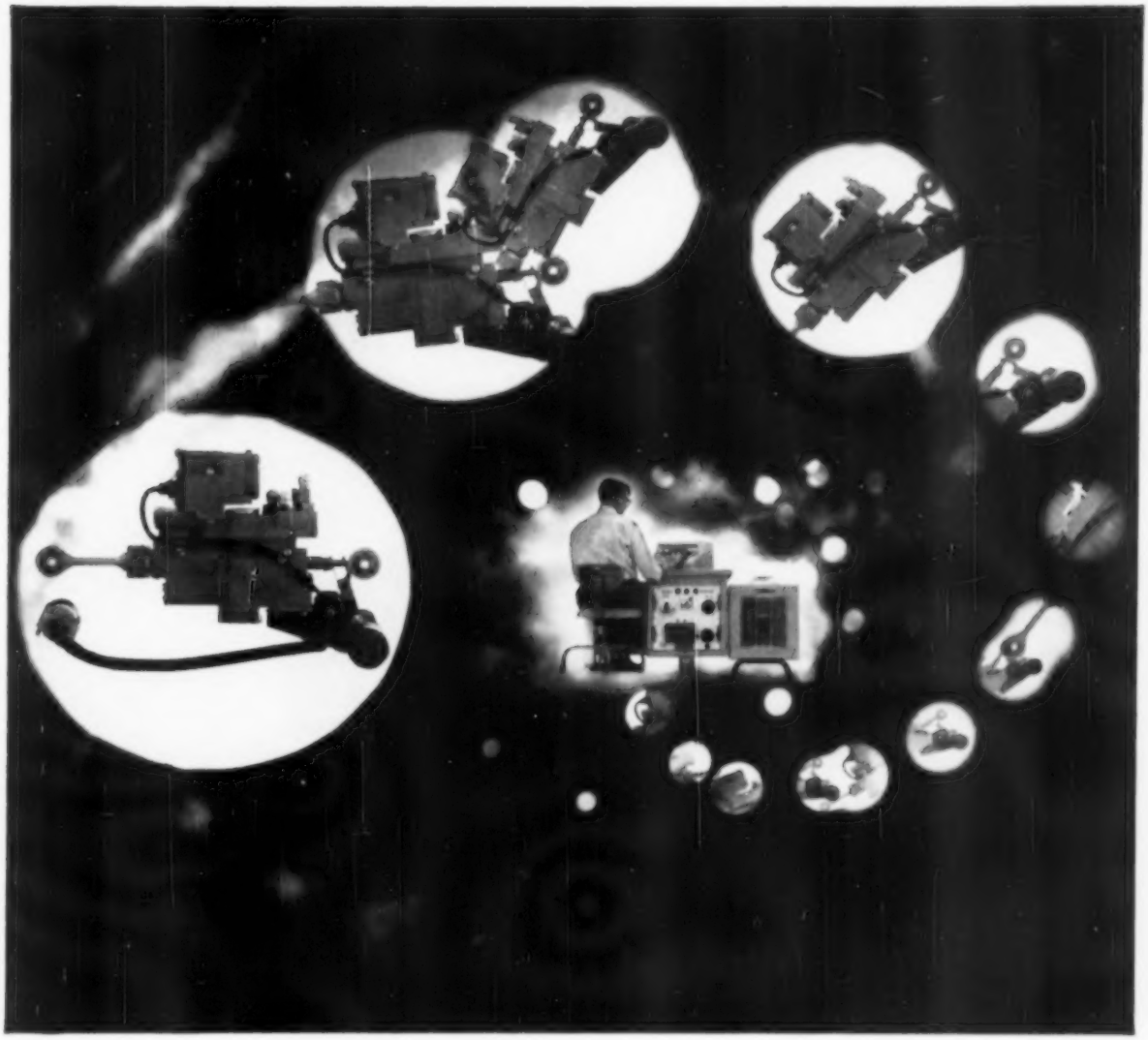
Plush interior for President Eisenhower's two Bell H-13J (Model 47J) helicopters includes a special arm rest which, when folded, makes back for middle seat (top, left and right). Interiors were handled by Horton and Horton, Fort Worth, Tex., aircraft specialists. Control column (below, left), includes box on top for engine starting button and landing light. One of the helicopters flies from White House lawn (right). Cost of two helicopters is $201,000.



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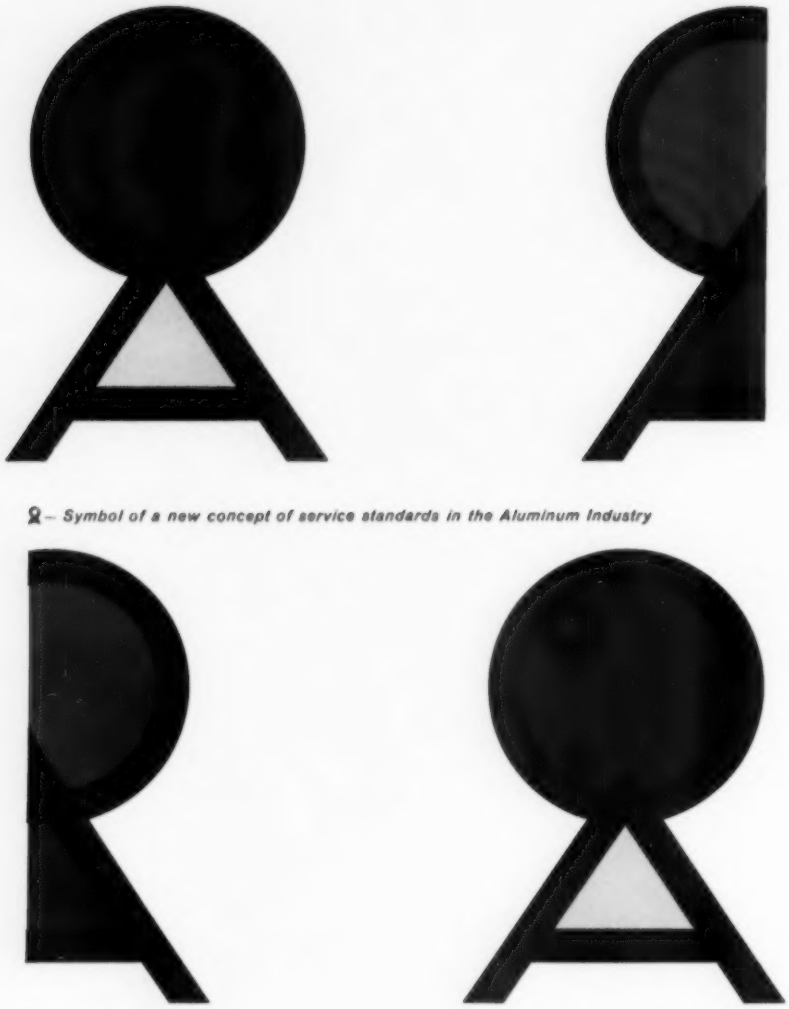

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which time cracks had grown to a total of 1 in.

Continuing to 7,300 cycles, cracks grew to adjacent frames (total crack length plus sawcut equaled 38 in.).

Crack Inception

In another test, a javelin with a blade length of 9 in. was dropped onto the skin midway between frames while 10 psi. air pressure was maintained within the specimen, with no rupture of skin occurring as the blade penetrated. A crack extended ¼ in. from each end of the cut and the air leaked slowly.

Convair engineers declare these tests clearly show the benefit of using relatively heavy 2024-T3 skins to resist crack inception and growth.

Convair is now testing a vertical aft section fuselage specimen incorporating windows to demonstrate fatigue (50,000 cycles) and failsafe properties.

Most comprehensive test will be conducted in a water tank with a complete fuselage integral with center wing section. Tentative plans are to apply 50,000 cycles of combined pressurization and flight loads, with landing loads interjected between cycles. Following this trial, a series of fail-safe tests will be made in which various members will be cut and loads applied to demonstrate that structure retains its integrity.

Test Cells Opened For the Iroquois

Toronto—First of six new test cells at Orenda Engines Ltd., Toronto, Ontario, was put into operation to test the new Iroquois jet engine to power the Avro CF-105 supersonic delta-wing fighter being built at the affiliated Avro Aircraft Ltd. plant at Toronto.

The new test cells, part of a $7 million test facilities expansion program, will all be completed before the company's annual summer vacation period. A second test cell for the Iroquois was scheduled for completion this month.

Test cells have been designed to accommodate future, uprated versions of the Iroquois, or new engines of a considerably greater size. They will handle engines with a mass flow of 50% greater than the present version of the Iroquois, more than any engine is likely to require in the next 10 years, George Anderson, Orendo's chief technical engineer, said.

One million dollars has been spent for silencing equipment for the new cells.

Noise is absorbed from the inrushing air by vertical members, or splitter vanes, filled with fibrous material. Behind the engine, the exhaust duct discharges into a silencer tube, 11 ft. in diameter, 45 ft. long and weighing more than 40 tons. This was

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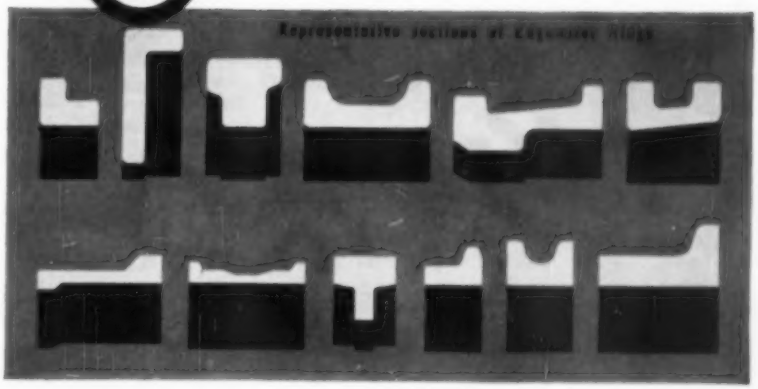

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specially designed by industrial Acoustics Inc. The system will reduce noise to about the level of that created by a passing tractor-trailer.

Engine exhaust gases are cooled to the point where the heat will not damage the silencing equipment. When the engine is running without afterburner, cooling is accomplished by flowing air around the duct. However, when the afterburner is lit, up to 3,000 gallons of water per minute will be injected directly into the exhaust duct for additional cooling. This will result in large volumes of steam which will be visible as it escapes from exhaust stacks.

The cooled gases flow into the vertical silencer and discharge to the atmosphere through a cylindrical pipe that rises vertically above the concrete stack of each cell.

To avoid errors in performance data resulting from uneven distribution of air temperature and pressure around the intake, the engine beds in the new cells are mounted on a raised, reinforced concrete plinth, placing the engine in the center of the cell's cross-sectional area. This area is 25 ft. wide and 25 ft. high, or almost twice as large as the cross-sectional area of some of the cells now being used.

Intake has been designed for straight-through flow. Vertical air intake stack would require a 90 degree turn in the air flow.

To give the test crew a direct view of the engine under test, the observation room has been elevated so that its floor is on the same level as the engine platform. This also provides the most direct approach for servicing and for the lines to the instruments. In some test cells of this type, the observation room is at ground level, necessitating use of a periscope or closed circuit TV to give the test crew a view of the engine.

At Orenda, the observation rooms for adjacent cells are back to back, and the space beneath them is available for storage and other services.

The engine's performance is logged in a central recording room, situated in a central service building and common to all six cells. In this room 2,500 signals, automatically transmitted from the test cells through 16 tons of electrical cable, can be handled simultaneously.

While much of this data will be logged by automatic recording equipment, some of it requires an observer. The ground work has been laid for the gradual introduction of more automatic data handling equipment. The central service building also accommodates offices and stores.

At Nobel, Ontario, about 120 miles north of Toronto, an afterburner test facility went into operation last summer. A rig for investigating internally cooled turbine blades is expected to be ready there for service soon.

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Republic Titanium Flies with

The B-58 is built for the Air Force by Convair, A Division of General Dynamics Corporation, Fort Worth, Texas. Powered by four General Electric J-79 engines, the plane is designed to operate at altitudes above 50,000 feet. Photo at left is one of the first showing detachable pod under fuselage. This feature permits performance of a greater variety of missions.

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Convair's B-58 Hustler

Republic titanium alloys used for elevated temperature applications and weight saving in America's first Supersonic Bomber

The delta-winged B-58's transformation from drawing board to production in record-breaking time is a tribute to the design-and-engineering skill of Convair Division, General Dynamics Corporation.

This dream plane incorporates the most advanced equipment and utilizes the latest engineering materials, including Republic Titanium.

Titanium alloy types produced by Republic Steel are used in the B-58 for weight saving and elevated temperature applications. These particular titanium alloys are among the strongest now being produced. They offer high strength values at elevated temperatures.

These alloy types have a minimum tensile strength of 130,000 p.s.i. and a minimum yield strength of 120,000 p.s.i. They meet the demand for high strength to resist the effects of aerodynamic heating in supersonic aircraft, such as the B-58.

The Hustler is the world's fastest bomber. What about the future? Right now, planes are being designed for speeds of Mach 3 or 4. Republic is keeping pace. At the Titanium Research Laboratory in Canton, Ohio, new titanium alloys are being developed with better physicals to provide greater operating efficiencies.

In exploring the "thermal thicket", many materials must be appraised and utilized. Republic—world's largest producer of aircraft steels—is working on new high-tensile, stainless types with higher strength and greater heat-resistance.

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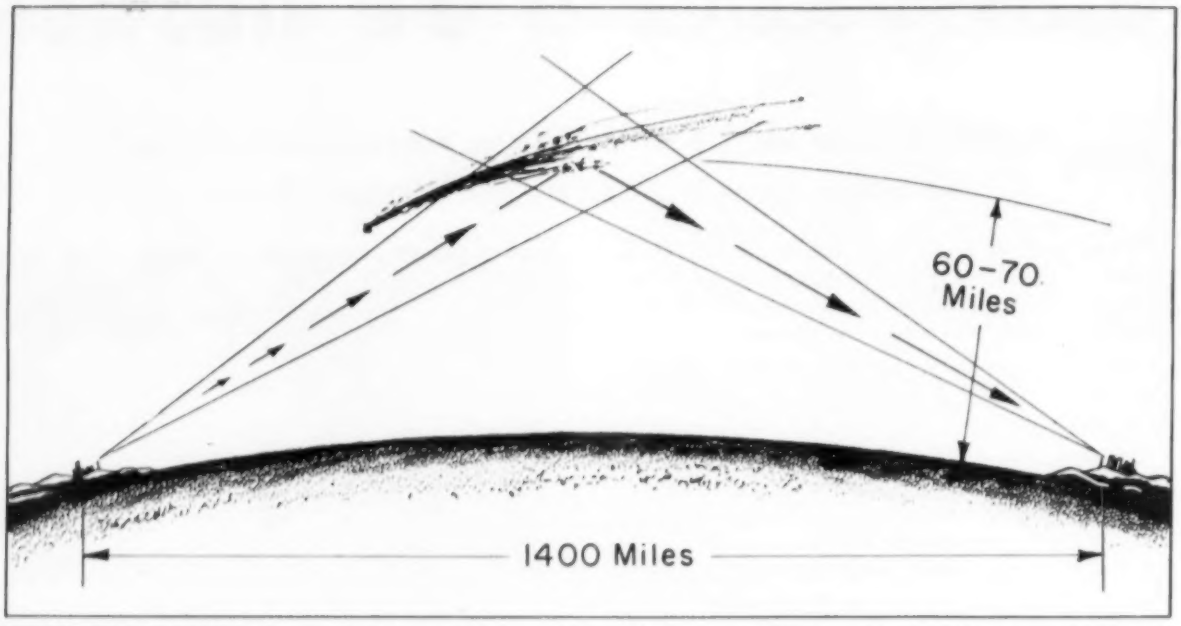


BOUNCING RADIO WAVES off meteor trails is new technique which enables low-power VHF transmitters to achieve ranges of 1,400 miles for voice, teletype, perhaps facsimile.

Meteor Burst Extends VHF Radio Range

By Philip J. Klass

Hanscom Field, Mass.—Meteor burst scatter communications, a new radio technique that can provide 1,400 mile voice, teletype and possibly facsimile transmissions at VHF frequencies with low powers, has been established by recent tests.

The new technique, which bounces VHF radio signals off meteor trails 60-70 miles above the earth, appears suitable for point-to-point, ground-air, perhaps for air-to-air communications.

First Transmission

The first successful voice transmission was made on April 20 by meteoric scatter at a frequency of 40 mc. between Bozeman, Mont., and Palo Alto, Calif., over a distance of more than 800 miles. Transmitter power was less than 1 kw., only 1/20 to 1/30 the power used in conventional ionospheric scatter. The project, carried out by Stanford Research Institute and Montana State College, is one of a number being sponsored by the Air Force Cambridge Research Center here.

The new meteor scatter technique in some ways resembles the ionospheric scatter technique first revealed about two years ago and currently in military use.

However, meteor scatter appears to have a number of significant advantages:

• **Greater security.** Meteoric scatter is far more selective in the size of the area in which usable signals are received, making it less susceptible to enemy interception and countermeasures than conventional ionospheric scatter.

• **Lower power.** Meteoric scatter can operate with far lower powers. For example the recent SRI voice tests used a single sideband transmission operating with 800 watts in the sideband, 100 watts in the carrier. Ionospheric scatter transmitters are usually in the 20-30 kw. size.

• **Greater bandwidth.** Ionospheric scatter has a usable bandwidth of about 10 kc. which limits it to a couple of voice channels or a handful of teletype channels. At low powers meteoric scatter can provide bandwidths of 15-20 kc. and at higher powers, comparable to ionospheric scatter, bandwidths of 100 kc. or more appear feasible. This means more channels and opens the way to moderately high-speed facsimile service. AFCRC is sponsoring a meteoric scatter facsimile investigation at Radio Corporation of America.

• **Smaller antennas:** Meteoric scatter requires less antenna gain, hence can use smaller antennas, as five or eight-element Yagis, instead of the large corner reflector or rhombic antennas required for ionospheric scatter. This, coupled with the lower transmitter power opens the way to using meteoric scatter communications in aircraft for ground-air and air-to-air service. It also makes small portable field units for tactical use feasible.

Meteoric scatter techniques appear usable from 15 mc. through 100 mc., with best results at 40 to 80 mc., according to Dr. Joseph P. Casey of AFCRC's Propagation Laboratory. Tests to date indicate that meteoric scatter is relatively unaffected by sunspots and Aurora disturbance but the National Bureau of Standards plans further tests at high latitudes, Casey says.

Trail of Ions

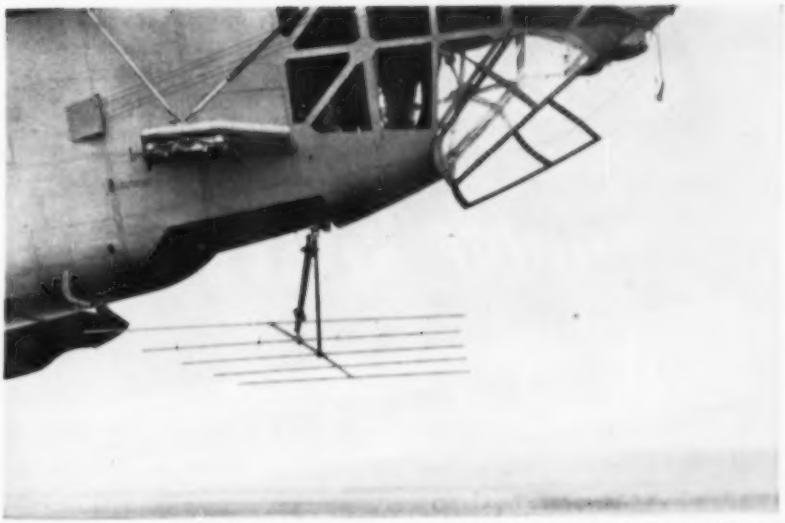
When a meteor strikes the earth's atmosphere at tremendous speed, it heats to incandescence, leaving a trail of ions and electrons in its wake in a 10-mile thick band at an altitude between 60 and 70 miles. At higher altitudes the meteor trails disperse too rapidly to be used, while at lower altitudes the ions and electrons recombine too rapidly.

The antennas at both terminals of a point-to-point meteoric scatter system, like those of a conventional ionospheric scatter system, are aimed at the same

portion of the ionosphere to form an intersection (see sketch). However, the lower gain meteoric scatter antennas have broader beams, frequently cover an area of roughly one spherical radian (approximately 60 deg. by 60 deg.).

The significant difference in the operation of the two scatter techniques is that ionospheric transmission can take place on a continuous basis whereas meteoric transmissions can be made only when a meteor trail forms in the area of the ionosphere intersected by the two terminal station antennas.

An average of two to three usable meteor trails will be produced per minute in the area of antenna beam intersection, but each trail lasts for only about one second. This means that meteoric scatter transmission can occur only for about two to three seconds out of each minute. The usable transmission time as a percentage of the total is frequently called the "duty cycle." It averages about 3-5%.



BLIMP equipped with Yagi antenna picked up VHF signals via meteor trails at distance of 1,300 miles.

High-Speed Transmission

The way to get around this comparatively low duty cycle is to transmit information in a burst at rates far greater than normal. If information can be transmitted at 20 to 30 times normal speed, then two or three one-second bursts per minute can provide essentially continuous communication without noticeable delay or interruption insofar as the end output is concerned.

This is accomplished by recording the voice or teletype message on magnetic tape which is temporarily stored in a bin until a meteor trail appears. The taped message then is transmitted at five, 10, or up to 80 times the speed at which it was recorded. At the receiving end this message is re-recorded on magnetic tape, then played back through teletype or voice channels at normal speed.

Under AFCRC sponsorship, NBS has transmitted teletype messages via meteoric scatter at 40 times the standard rate with rather small errors. The NBS equipment is designed to operate at compression ratios up to 80:1.

The recent voice transmissions made by SRI used compression ratio of 5:1. Dr. Casey says that a further step-up in voice compression appears feasible. A tape recording of the SRI transmission heard by AVIATION WEEK showed very good intelligibility over the 800 mile route.

Because it is impossible to predict when a meteor will strike, and because its trail remains usable for so brief a time, the meteor trail must be detected quickly and the taped transmission must be instantly turned on, then shut off when the trail disappears.

In a typical two-way system, each station has a transmitter, receiver, an antenna for each, plus two high-speed tape units, one for transmitting and the other for recording the other stations message.

Each station continuously transmits an unmodulated carrier and has its own receiver tuned to the other station's transmitter. In the absence of a meteor trail, neither signal gets through. When a trail does appear, each station receives the other's unmodulated carrier. This triggers each station to transmit a "start" signal, either by applying sine wave modulation to its carrier or by a slight shift of carrier frequency.

Two Meteor Categories

Receipt of the "start" signal triggers each station to start its high-speed transmission and to record the broadcast from the other station. When the received signal drops below a preset minimum, indicating that the meteor trail is playing out, both stations shut off their transmission and return to stand-by condition to await the next meteor.

Scientists currently classify meteor trails into two sizes, depending upon their electron density which determines the nature of their propagation characteristics:

• **Under-dense** has less than 10^{14} electrons per meter in trail, lasts about one

Mistaken Identity?

Concept of meteor trails as a radio signal propagation mechanism is credited to a group of Stanford University scientists, including Drs. O. G. Villard, A. M. Peterson, L. A. Manning and V. R. Eshlemen. However the National Bureau of Standards is credited with conceiving the idea of meteor burst communications and the Canadian Radio Physics Laboratory was the first to exploit the technique in a point-to-point teletype system.

Two years ago, when scatter communications was declassified, scientists were in sharp disagreement over the basic mechanism responsible for ionospheric scatter propagation. It was agreed that scatter resulted from upper air ionization, but the cause of this ionization was uncertain. Many scientists held that it resulted from solar radiation.

However, Dr. Villard, as reported by Aviation Week at that time (April 18, 1955, p. 77) took sharp issue with this explanation. "Villard's theory is that ionization caused by meteor trails plays a dominant role. He presented limited data which indicates that propagation is best at times of intense meteor showers," Aviation Week reported.

Additional research in the past two years has clearly confirmed that meteor-caused ionization is indeed a radio propagation mechanism. In fact, more scientists are beginning to suspect that ionization produced by meteors too small to be visible may be responsible for all ionospheric scatter, as Dr. Villard originally proposed. However, there is still a division of opinion.

If further research should establish that meteor trails are responsible for both conventional ionospheric scatter and the new meteoric scatter, the difference in their performance characteristics would then be due solely to the different transmission techniques employed.

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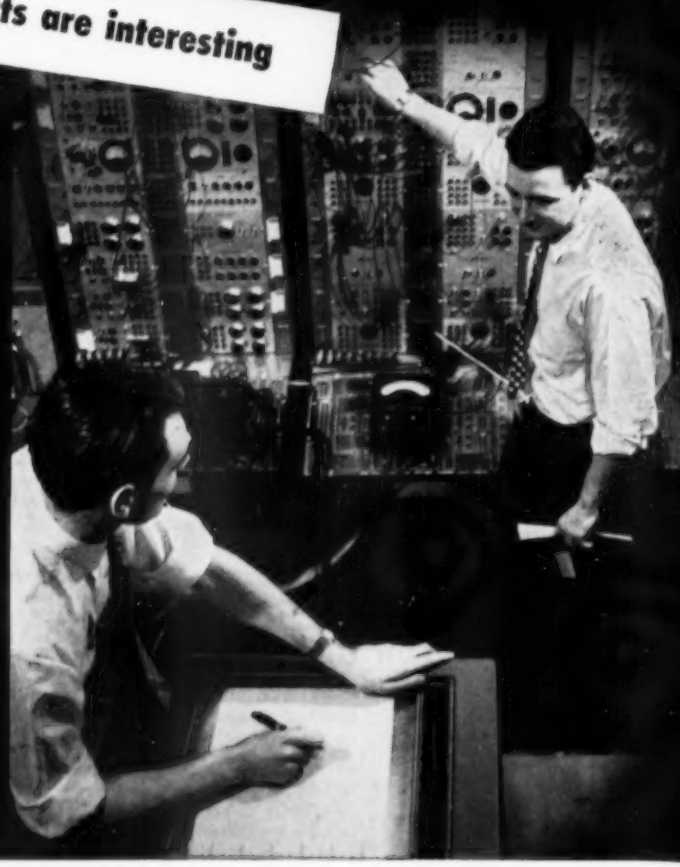

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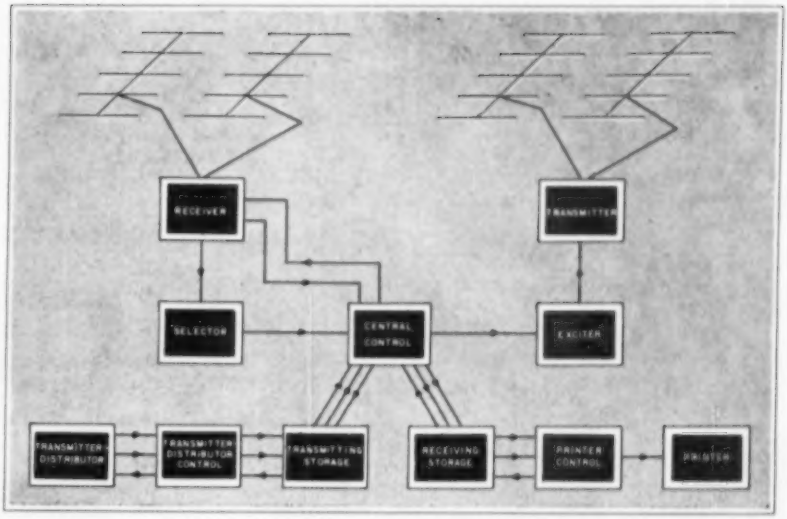
second. The under-dense type is preferred for meteoric scatter because it behaves more like a mirror, reflecting the signal in accordance with the familiar angle of incidence relationship and providing a relatively small area of reception. For military applications this provides a degree of security.

• **Over-dense,** with more than 10^{14} electrons, may last for several minutes but produces considerable scattering. This degrades the security of communications and may result in multipath propagation that limits usable bandwidth.

Current studies are underway to develop techniques for discriminating between the two types of meteor trails. One promising technique appears to be the use of signal rise-time, or the rate of signal build-up. Over-dense trails have higher build-up rates.



METEOR BURST communication system, shown schematically, would be duplicated at each terminal.

Basic Study Spur

Ionospheric scatter, and the more recent meteoric scatter, has spurred basic studies into meteors and their origin. Much of this basic work is being carried out by Stanford University, under AFCRC sponsorship.

For example, Stanford is using very high power radar to search out extremely small meteors not visible to the eye. If such meteors exist in heretofore unsuspected quantities, they might explain the mechanism responsible for steady state ionospheric scatter (see box, p. 97).

Stanford also is measuring the rates at which meteors strike the atmosphere and the direction from which they come (radiants). Most meteor orbits appear to lie in the ecliptic plane (solar system equator).

AFCRC itself has conducted studies on the size and shape of the area in the vicinity of a meteor scatter station in which it is possible to eavesdrop. These investigations indicate that the reception area is an elipse, with a long axis of 100-200 miles (in line with the antenna beam) and a short axis of about half of these distances.

Georgia Tech's Research Institute is participating in the AFCRC program by monitoring continuous-wave transmissions for Walpole, Mass., propagated via meteor scatter, at two sites, one in Atlanta and the other at Columbia, S. C. NBS is operating a meteor burst teletype system experimentally between Walpole and Sterling, Va.

The Navy and Army Signal Corps also have active meteoric scatter programs underway with undisclosed contractors.

One of AFCRC's most important meteoric scatter programs is RCA's investigation to determine the feasibility of transmitting a complete facsimile picture in the brief interval of a single meteor burst. Within the next 30 days RCA is slated to test such a system over a distance of 800 miles, between Riverhead, L. I., N. Y. and the NBS facility at Havana, Ill.

Facsimile Program

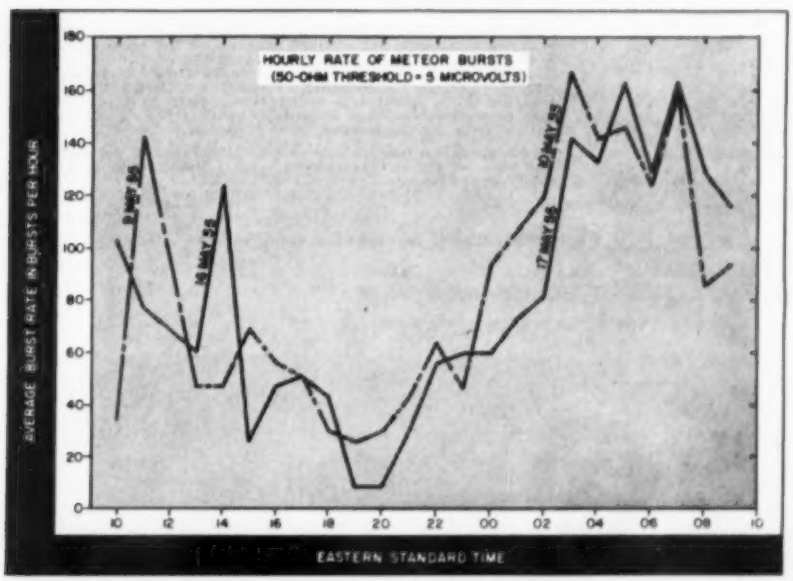
To achieve the greater bandwidth required for facsimile, RCA plans to use 20 kw. transmitters and 20 db. rhombic antennas. To provide a margin of safety, RCA plans to transmit in a half-second interval.

The experimental equipment is designed to provide a variety of different combinations of resolution, picture size and bandwidths. Scanning rates can be selected between 200 and 800 lines per second, requiring video bandwidths of 13 to 213 kc.

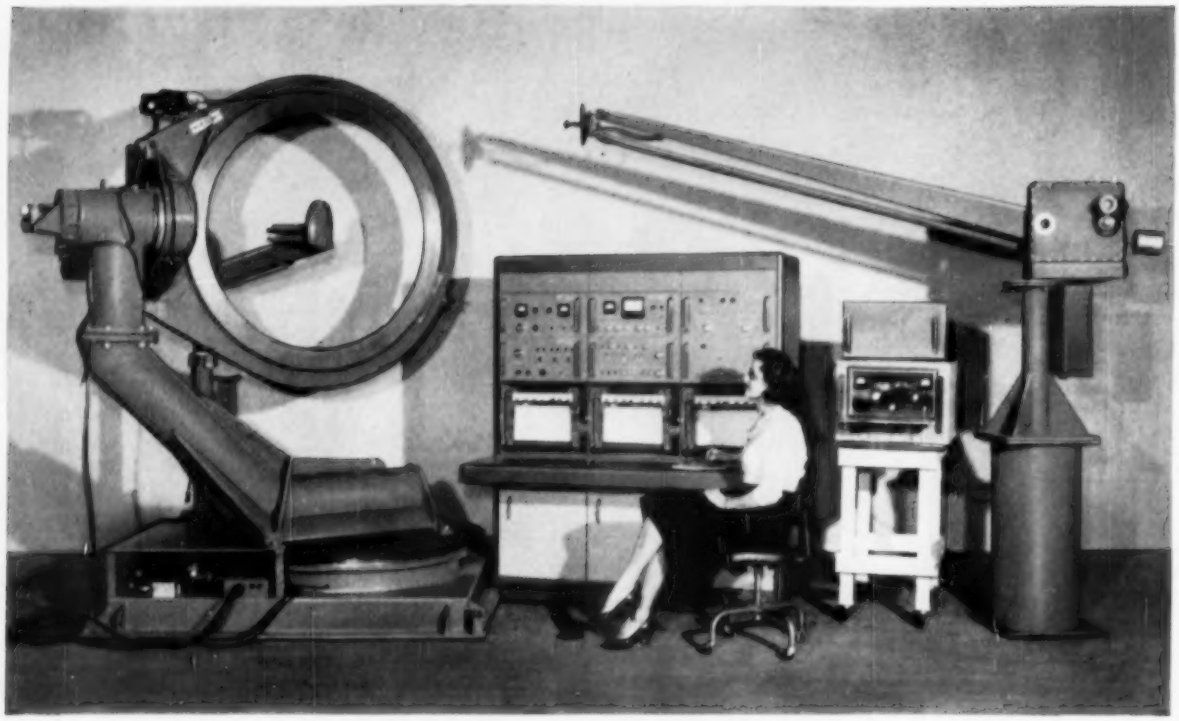
A hybrid using both conventional ionospheric and meteroic scatter techniques may provide a more versatile system utilizing the advantages of both techniques, Casey believes.

Such a system could operate as a conventional ionospheric scatter system, transmitting narrow bandwidth teletype messages on a continuous basis, for example, until a meteor trail was detected. Then it could automatically switch over, transmit a burst of voice or facsimile, then switch back to continuous teletype until a meteor trail was detected.

This would ease the limitation of a pure meteoric scatter system that re-



VARIATION of meteor strike rate during 24-hour period. Data: Bureau of Standards.



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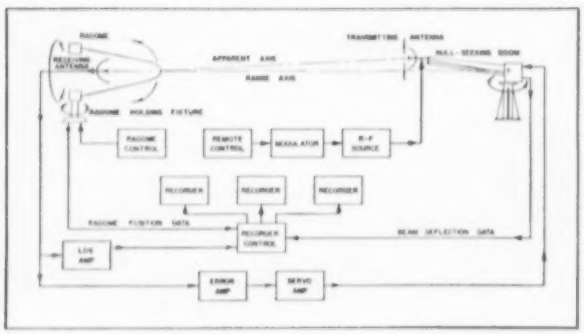

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As the motor-driven holding fixture rotates the radome under test, the servo-controlled, null-seeking antenna on the boom traces the position of the deflected radar beam. At the control console, under supervision of a single operator, three recorders plot the total magnitude and the horizontal and vertical components of the beam deflection angle directly in milliradians. Rate of change of the beam deflection, essential to missile applications, is readily obtainable from the recordings.

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sults from the fact that the rate of meteor activity, and hence its effectiveness as a propagation medium, varies roughly sinesoidally with the time of day and the season.

Maximum meteor activity takes place around 6 a.m. and the minimum occurs around 6 p.m. Seasonally, meteor activity is at its peak around September and at its lowest around March. Over a 24-hour period in September the meteor rate may vary as much as 4:1, while the variation goes as high as 14:1 in March. Lower meteor rates result in lower duty cycles.

AFCRC has explored ground-air transmissions via meteor scatter on only a limited basis, using a blimp equipped with a five-element Yagi antenna. Signals were received from a transmitter at Cedar Rapids, Iowa, at distances up to 1,300 miles, Casey says.

Although such an antenna is far too large for use on a high-speed aircraft, Casey is optimistic that the meteor scatter technique can be applied to ground-air, possibly air-to-air communications.

Expansions, Changes In Avionics Industry

University Research Consultants is name of new consulting engineering firm which will specialize in inertial guidance, drone formation control, ballistics, systems analyses, computers and applied physics. Company's address: 211 Delaire Bldg., 8147 Delmar Blvd., St. Louis 24, Mo.

Other recently announced changes and expansions in the avionics industry include:

• **Raytheon** has taken over management of Navy missile facility at Bristol, Tenn. for production of Sparrow III air-to-air missile. Facility previously was operated by Sperry-Farragut Co. to produce Sparrow I.

• **International Electronic Research Corp.** has licensed Inter-Technique of Paris to market its tube-cooling shields in Europe, except in Sweden where sales are handled by Bo Palmblad Aktiebolag of Stockholm.

• **Hoffman Electronics Corp.** has formed new Solar division in Evanston, Ill., to develop and produce solar energy converters, as part of Hoffman's Semiconductor Division, also in Evanston. Company also has formed new Semiconductor Equipment Design Section to develop new equipment using semiconductors.

• **Litton Industries** will build new 60,000 sq. ft. tube manufacturing facility in Salt Lake City which is expected to employ about 600. New plant, company's eleventh, will operate as part of its Electron Tube Division in San Carlos, Calif.

• **Elgin National Watch Company's Micronics** Division will build new 20,000 sq. ft. research and development facility in the Canoga Park Industrial area of the San Fernando Valley near Los Angeles. Occupancy is slated for Sept. 1.

• **Cohu Electronics, Inc.**, San Diego, newly formed company headed by La-Motte T. Cohu, has taken over **Kay Lab**, San Diego, also headed by Cohu, in a stock exchange.

• **Electronic Plastics, Inc.** is name of newly formed company engaged in extruding high temperature plastic insulated wire and custom molding of electronic component parts. Warren L. Schnur is president. Sales offices are located at 521 Fifth Ave., New York 17, N. Y.

• **Leach Relay Division of Leach Corp.** has opened new $250,000, 15,000 sq. ft. addition at 5915 Avalon Blvd., Los Angeles, representing a 40% increase in floor space.

• **Electronic Engineering Co. of California** has moved to 1601 East Chestnut St., Santa Ana, Calif.

• **Research Instrument Co.** of Portland, Ore. has moved to larger quarters at 7962 S.E. Powell Blvd., giving company 400% increased working area.

• **Digitronics Corp.** has moved to Albertson Ave., Albertson, L. I., N. Y.

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Inspecting T2J mockup: (in cockpit) Tom Clancy, Engineering Manager Trainer Projects, NAA Columbus; (left to right) executive secretary Lloyd A. Chacey, retiring president Alfred H. Sanborn, president Elmer S. Barrett, all of Ohio Society of Professional Engineers.

Invitation to the best engineers in Ohio (...or anywhere else!)

This is a mockup of the new T2J Navy jet trainer, designed and engineered by the Columbus Division of North American Aviation.

Displayed at the invitation of the Ohio Society of Professional Engineers at its 1957 annual meeting, the T2J is a graphic example of U. S. Naval aircraft engineering progress. It is the logical follow-on to the long line of distinguished standard trainers for which North American has been famous for over a quarter of a century. Designed as a basic trainer for jet pilots in all branches of the Armed Services, the T2J's performance is equal or superior to the nation's first jet fighters.

As an engineer, you can appreciate that many of our interesting projects cannot be exhibited in a public place. The performance and ability of these new aircraft startle the imagination of even the most advanced engineers. The requirements they impose offer challenges to every engineer currently working on them. They will do the same for you.

There's a fine future for you in applying your knowledge, experience and talents to the advance of Naval Aviation in the fields listed below. Write today.

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Contact: Mr. J. H. Papin, Engineering Personnel Manager, Dept. 56 W-6, North American Aviation, Inc., Columbus 16, Ohio.

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NORTH AMERICAN AVIATION, INC.

FILTER CENTER

▶ **Neck and Neck**—Airborne tests to evaluate relative performance of suppressed-carrier single sideband (SSB) and General Electric's synchronous detection, being run by Rome Air Development Center, show two systems to be roughly equal in performance so far. Critical test will come this summer when the airplane operates in the far north to evaluate each system's vulnerability to Aurora blackouts.

▶ **Flight Recorders for UAL**—United Air Lines will install the General Mills flight recorder in its new DC-8s. Device will record altitude, airspeed, vertical acceleration, magnetic heading and time.

▶ **New RCA Single Sideband**—Air Force is testing a suppressed-carrier single sideband version of its AN/ARC-21 HF communications transceiver. Modification, developed by Radio Corporation of America which designed ARC-21, involves no increase in size or weight and can be quickly accomplished. New SSB version is designated AN/ARC-65.

▶ **Military Adoption**—Aircraft Radio Corporation's lightweight automatic direction finder, Type 21A, developed originally for civil aircraft market, has aroused sufficient military interest to receive an official military designation: AN/ARN-59.

▶ **High-Power, High-Frequency Transistor**—Silicon power transistor capable of putting out 5 watts at a frequency of 10 mc. has been developed by Bell Telephone Laboratories under military sponsorship. The new PNIP deffused emitter and base transistor has an alpha cutoff frequency of about 100 mc., unilateral gain above 20 db. and collector efficiency of over 40 percent. Some laboratory samples have delivered as much as one watt output as an oscillator at 100 mc., BTL reports.

▶ **An Open Secret**—"One of the secrets of good relations between a corporation and its engineers is to share the effort and share the profits," according to Dr. Robert S. Bell, president of Packard-Bell Electronics Corp. The company sets aside 10% of its annual net earnings before taxes for profit sharing in the form of company stock.

▶ **NATO to Use Scatter**—Supreme Headquarters Allied Powers Europe has issued letter of intent for engineering and installation of tropospheric scatter communications and line-of-sight radio relay links to integrate NATO com-

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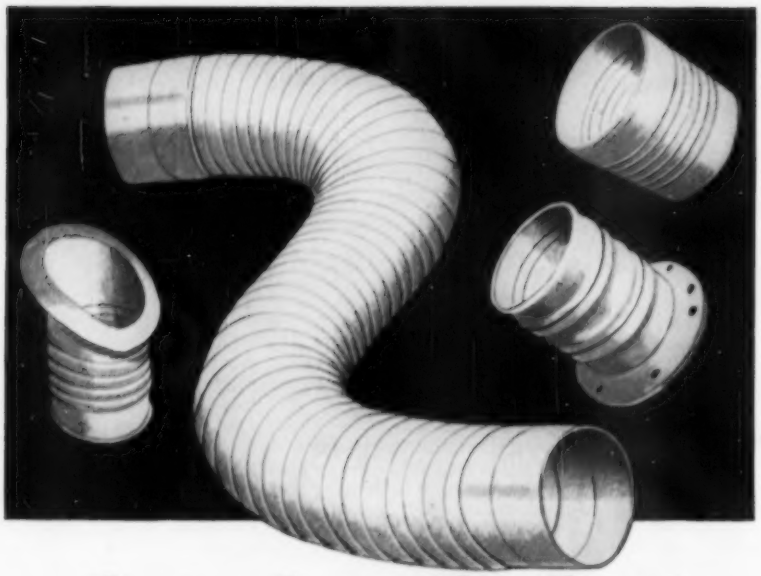

facts about Flexflyte®

that will help you solve your aircraft ducting problems

What is Flexflyte?
A lightweight, reinforced ducting made of a spring steel wire helix covered with coated fiber glass or a cotton fabric and bound with a fiber glass cord.

What are its applications?
Flexflyte is designed for use with ventilating, defrosting, de-icing and hydraulic systems.

How flexible is Flexflyte?
It will take tight turns at any point up to 180° without buckling. No elbows or fittings are required.

What are its temperature ranges?
From minus 120°F. to plus 650°F.

What about Flexflyte's resistance to abrasion?
It is highly resistant to abrasion, especially when coated with FT-506 which has more than 200 times the abrasion resistance of any tubing of its type and weight.

Is it flame resistant?
Flexflyte has exceptionally high flame resistance and will not support combustion.

What pressures will Flexflyte handle?
Internal working pressures up to 70 psi and external working pressures up to 15 psig, depending on type.

What about installation?
Flexflyte is quickly, easily installed around corners and equipment parts by means of metal clamps. It is also available with special enlarging or reducing ends, either cylindrical, rectangular or polyhedral.

Can Flexflyte be engineered for unusual applications?
Yes, in many special shapes, fabrics, coatings, connections, lengths and diameters. Our special Silicone Department, working with automated machinery, is prepared to meet any requirement for silicone ducting.

How can I make sure that Flexflyte will solve my problems?
Write us, outlining your requirements. Our engineers will be glad to put their experience to work for you. Write Dept. 206.

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munications, stretching from Eastern Turkey around a broad crescent through NATO Europe to Norway. Contract went to subsidiary of International Telephone & Telegraph Corp. and to Hycon Eastern, Inc., Cambridge, Mass.

▶ **New High Temperature Semiconductors**—Transistors made from new compounds, like gallium arsenide, may be able to match the high frequency characteristics of germanium, yet work at temperatures several hundred degrees higher than silicon. This prediction comes from Dr. Dietrich Jenny of the Radio Corporation of America's David Sarnoff Research Center. Dr. Jenny reports that RCA has made experimental transistors and diodes with new compounds that can operate at 850F. USAF is sponsoring the RCA program.

▶ **New Infrared Detector**—Infrared detector that reportedly is sensitive out to 7 microns, has a time constant of less than one microsecond, a noise equivalent power of approximately 6.001 microwatt and requires no cooling or bias voltage has been developed by The Radiation Electronics Corp., 8241 North Kimball Ave., Skokie, Ill.

▶ **New Arinc Transponder Spec**—Aeronautical Radio Inc. has released revised version of its Characteristic No. 532A for an Air Traffic Control Transponder. Copies are available upon request. Arinc's address: 1700 "K" St. N.W., Washington, D. C.

▶ **FTL Guides Lacrosse**—Federal Telecommunication Laboratories reports that it developed the guidance system used in the Army's new Lacrosse surface-to-surface missile, under contract to the Cornell Aeronautical Laboratory, which developed the missile.

▶ **Show-Off**—Aircraft Electrical Society will hold annual display of latest aviation electrical products, Oct. 24-25, in the Pan Pacific Auditorium, Los Angeles.

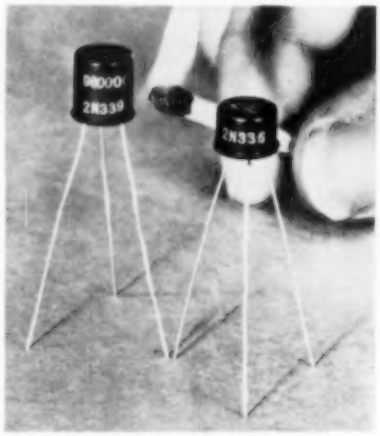
▶ **New Arinc Spec**—Aeronautical Radio Inc. has issued new characteristics for Vortac airborne distance measuring equipment, or DME-T for short. Copies of Characteristic No. 521B are available at no charge by writing to Aeronautical Radio Inc., 1700 "K" St. N.W., Washington, D. C.

▶ **Dark Eyes**—Military TV camera which can see as well as a man with 20/20 vision in a room illuminated by an ordinary match has been developed by Admiral Corp. for Navy Bureau of Aeronautics. Compact TV camera can be used for airborne or under-water reconnaissance, Admiral says.

NEW AVIONIC PRODUCTS

Components & Devices

• **Silicon transistors,** in 15 new types suitable for 150C operation, have been announced by Texas Instruments Inc. Two of the new units are NPN grown-diffused switching transistors with total switching times down to 100 milli-



microseconds, featuring high alpha cut-off frequencies and low collector capacities. The other 13 types include three high frequency tetrodes, five medium-power units and five small-signal devices. Company's address: 6000 Lemmon Ave., Dallas 9, Texas.

• **Subminiature precision trim pot,** wire wound, has connection tabs to permit mounting in printed circuit boards. Units measure ¼ in. dia., weigh ¼ oz., come with resistances of 10 to 150,000 ohms, rated 2 watts at 60C, suitable

for operation over temperature range of −55C to 125C, moisture proof and anti-fungus treated. Technical Data Unit No. 563 gives application data. Ace Electronics Associates, Inc., 103 Dover St., Somerville 44, Mass.

• **Permanent magnet alternator** operates at 12,000 rpm, delivers 500 to 4,500 volt-amps of 400 cps power. New unit has no slip rings, commutators or brushes, greatly easing explosion hazard and radio interference. LearCal Div., Lear, Inc., 3171 South Bundy, Santa Monica, Calif.

• **Miniature encapsulated selector switch,** Series BHM, measures only ⅞ in. dia. x 1⅛ in. long, has contacts rated 50 ma. at 300 v.a.c. or d.c. and 500 ma. at 30 v.a.c. or d.c. Unit is available in SP with 12 positions, DP with 6 positions, 3P with 4 positions or 4P with 3 positions, in either shorting or non-shorting contacts. Clarostat Mfg. Co., Inc., Dover, N. H.

• **High temperature potentiometer,** Type K, can be operated at 150C at reduced rating, or at 100C rated at 2 watts. New variable resistor uses hot molded resistance track, is available in variety of tapers with electrical taps. Allen-Bradley Co., 136 West Greenfield Ave., Milwaukee 4, Wis.

• **High-power silicon rectifiers,** with ratings up to 140 amps per cell, in small, lightweight units are now available from General Electric Co., Schenectady, N. Y. Bulletin GET-2689 gives application data.

• **Subminiature tubes,** new series of seven designed for missile use, have been announced by Sylvania. Four of the

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FRIENDLY ATMOSPHERE . . . they work with congenial people who share the same interests as they.

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Valve Talk

FOR WM. R. WHITTAKER CO., LTD.
BY MARVIN MILES

Are you in the market for a bearing that will withstand heat — phenomenal heat?

Will you believe it if I tell you Whittaker has developed a lightweight sleeve bearing that will shake off 4,000-degree temperatures and run completely dry without seizing?

It's difficult to believe, I know, because it's such a revolutionary achievement, but it's true nevertheless. I've seen it operate like a charm under the continuous searing blast of an acetylene torch. It's incredible when you consider that the average sleeve bearing under similar conditions will take only about 500 degrees before it binds.

Yet there it is, operating daily at Whittaker in four different test applications.

The company is naturally a little cautious about the secret of their development, although 18 months of work on the project is protected by patents-applied-for.

The job was undertaken because of continuing problems with standard bearings under high temperatures and because high-heat ball bearings – developed especially to withstand 1,400 degrees – cost too much and penalize overall design with excessive weight and cumbersome size.

The results of this work have astounded everyone!

Now Whittaker awaits problem statements, specific sets of realistic conditions to which they can apply the bearing and prove its worth.

The research department doesn't feel their development will eliminate costlier, heavier ball bearings – there's a place for both types—but they do feel the new sleeve unit will be particularly applicable to such high-heat problems as afterburner areas, thrust reverser links, silencer links and engine emergency systems where light weight and positive action are musts.

In addition to the fantastic heat the bearing will take is its amazing ability to run bone-dry, but then Whittaker explains that any lubricant would be of no use at such extreme temperatures, for it would either turn into an abrasive, burn or gasify.

The dual secret in the bearing, of course, is material and design, and I might add here that any shaft that it holds must be of compatible alloys or it will turn into a piece of cheese under 4,000 degrees while the bearing stands up imperturbably, glowing red hot.

Typical failure of bearings-under-heat heretofore has been their inability to handle oxides formed under high temperatures. The oxides accumulate to scale-like proportions until the shaft can no longer rotate. It binds, or welds, and that's that.

Whittaker's new bearing is designed to provide an area where these waste products can be distributed. It continuously wipes away the dangerous products of wear into no-pressure areas where it cannot affect the rotation of the shaft.

In the laboratory tests I watched, a 130-pound static load was placed on the bearing through a 10-to-1 ratio arm. The shaft inserted through it was turned up to 3,500 r.p.m. by a bench lathe. Then an acetylene torch was fired and held within a half inch of the assembly, subjecting it to an outside heat of some 6,000 degrees.

Both journal and journal box turned red hot as the lathe whirred the shaft steadily for long moments. Finally the outside end of the shaft began to melt, but the bearing itself was unaffected.

The lathe was shut down and the torch removed.

"Can we try it again after it's cooled?" I asked.

"Sure, why not?"

I stood by for several moments while the cherry color vanished from the metal, and then the engineer hit the lathe switch and once more applied the torch. No difference. The cooling process had had absolutely no effect.

"Want to try for three?" the engineer grinned.

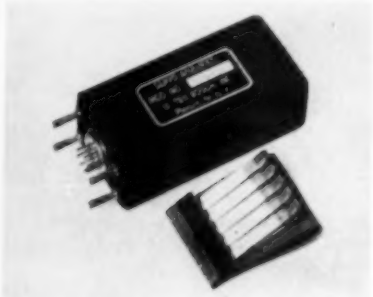
All the possibilities of the bearings are not yet known. It has been impossible, so far, to test it under all conditions. But in all tests to date it has functioned perfectly at astounding temperatures and still sustained a good fit in continuing on-and-off, fully-dry operation.

An achievement badly needed — an item without equal.

new types (6788, 6943, 6944, and 6945) are pentodes, two are double triodes (6947 and 6948) and the type 6946 is a triode. All seven types reportedly have passed white-noise vibration test, are rated for maximum bulb temperature of 250C and maximum plate voltage of 250 volts.

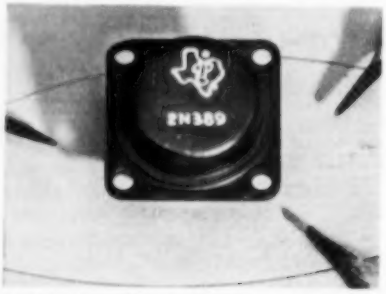
• **Miniature pull-type solenoid,** designed to MIL-S-4040, capable of operating at temperature of −65F to 100F, is available with operating voltages of 6 to 100 v.d.c. and with plunger operating under side force of 8 to 10 gr. Typical operating characteristic: at 100 v.d.c., 0.3 amps, 0.03 in. stroke, force is 1.3 lb. Carruthers & Fernandez Inc., 1501 Colorado Ave., Santa Monica, Calif.

• **Transistorized servo amplifier,** called "Tramps", is designed to drive a size 15, 400 cps 6.1 watt servo motor, Kearfott Type R110-2 or equivalent. Temperature range is −55C to 100C, or 125C intermittent. Voltage gain is



1,600 at 6 watts output; input power requirement is 100 ma. at 100 v.d.c. and 12 ma. at 28 v.d.c. Unit measures approximately 1¼ x 1¾ x 3¾ in., weighs 7 oz. M. Ten Bosch, Inc., Pleasantville, N. Y.

• **High-power silicon transistor,** Type 2N389, made with new gaseous diffusion process, is rated 37½ watts at 25C, 15 watts at 100C. Transistor has operating temperature range of −65C to



150C, has 60-volt collector-to-emitter rating which permits operation direction from 28-volt d.c. aircraft supply. Texas Instruments Inc., 6000 Lemmon Ave., Dallas, Tex.

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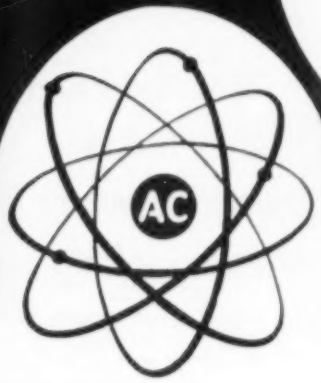

DESIGN — You create basic design concepts based on practical means of accomplishment. Your concepts are translated by layout draftsmen to a more communicable form under your guidance. In other words, HOW, WHAT, WHY, WHERE systemized.

DEVELOPMENT — You evaluate, refine and improve; using the finest PRODUCT IMPROVEMENT TOOLS. These "TOOLS" include the best TEST and RESEARCH facilities available and you have the added advantage of working alongside the top men in this field.

PRODUCTION — You supervise the evolution of a production model based upon engineering prototypes resulting from the Design and Development. Produceability and a high degree of reliability will be your responsibility. Your job will include the maintainability and function of Electro-Mechanical Devices, Precision Gear Trains and Packaged Electronics in the fields of Inertial Guidance, Avionics and Jet Engine Fuel Controls.

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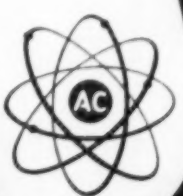

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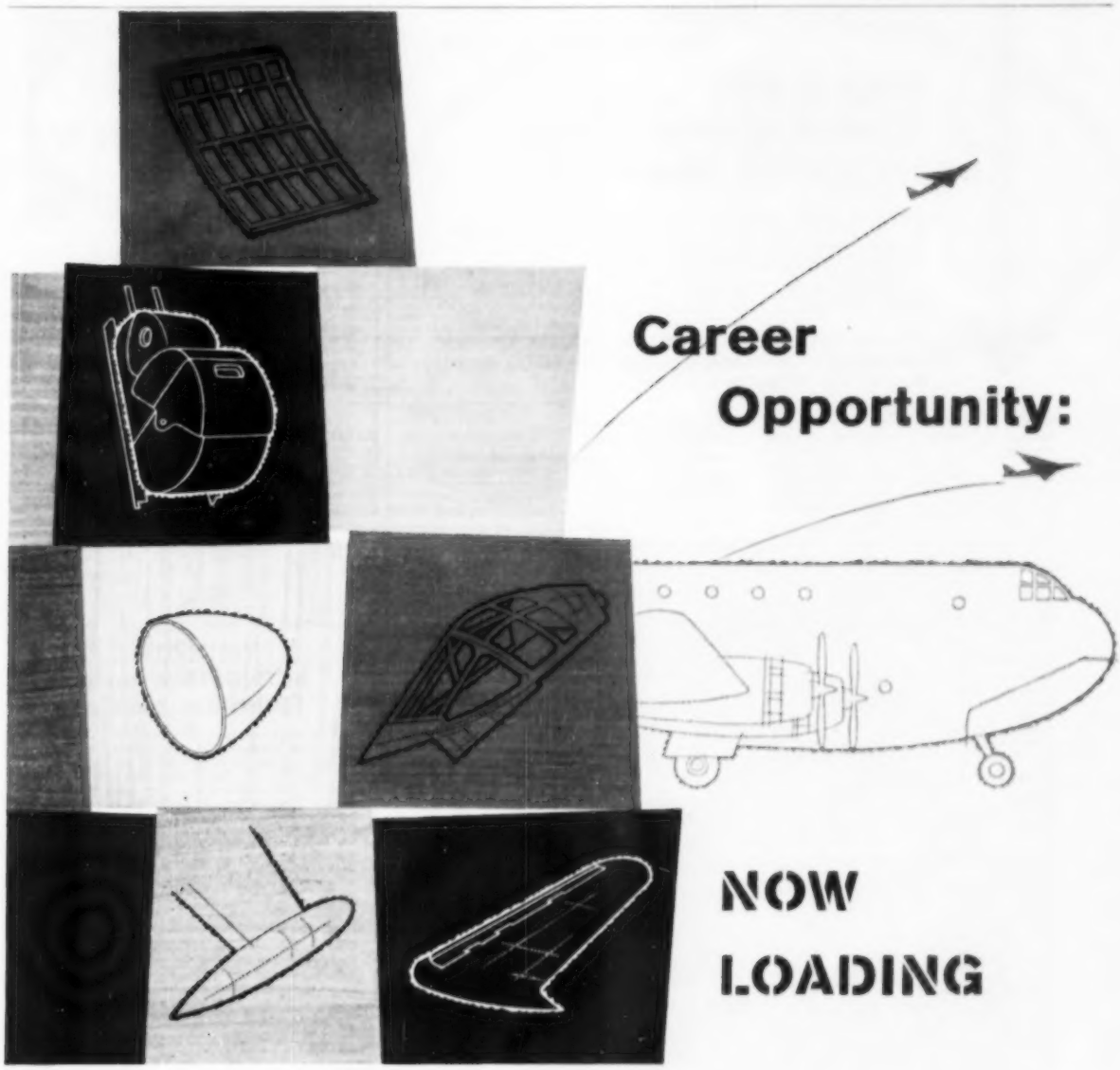

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All this spells opportunity unlimited for engineers. Our continued growth and diversification have required expansion of our engineering staffs in all specialties at both Akron, Ohio, and Litchfield Park, Arizona. Available for your use are the most modern engineering and research laboratories, including a large computer laboratory.

If you have an eye to the future — and it's focused on the sky — a rewarding career can be yours at Goodyear Aircraft. Salaries and benefits are liberal, of course. And if you wish to continue your academic studies, company-paid tuition courses leading to advanced degrees are available at nearby colleges.

For further information on your career opportunities at Goodyear Aircraft, write: Mr. C. G. Jones, Personnel Dept., Goodyear Aircraft Corporation, Akron 15, Ohio.

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QUALITY CONTROL ENGINEER
Require experience in gyroscopic trouble shooting. Design knowledge of stable elements and some background regarding reliability and failure association for complex guidance systems to be used in missile field. Must have complete knowledge of statistical methods.

TEST ENGINEER
Performs and assists in testing complex inertial equipment and in particular the inertial platform. Must be capable in directing the duties of test technicians and maintaining rigid production schedules. Must have experience in gyroscopic and basic gyroscopic test techniques.

TEST ENGINEER
Performs and assists in testing activities of complex computers for fire control and guidance systems. Must be capable of directing the duties of test technicians and maintaining rigid production schedules. Experience should include a background in basic test techniques in the above field.

OPERATIONAL EVALUATION ENGINEER
Conduct operational checks on electronic and electromechanical systems, locate and evaluate deficiencies and report on specific phases of the environmental test program.

DEVELOPMENT ENGINEER — CIRCUITRY
Research and development engineering work in radar pulse circuits, sweep and indicator circuits, intermediate frequency amplifier circuits, and feed back amplifiers. Must have post graduate experience in circuit development engineering with applications in both radar and countermeasures fields.

PRODUCT ENGINEER
Initiate, compile and maintain design standards on electrical, electronic and mechanical design subjects pertinent to fire control equipment and inertial guidance components. Must have considerable responsible experience on product design standards covering areas indicated in job studies.

PROJECT ENGINEER — AIRBORNE EQUIPMENT
Project engineering of computers, pro and anti submarine fire control equipment, airborne navigation plotting equipment and similar equipment. Preparation and proposals on equipment of such types.

RELIABILITY ENGINEER
Develop methods for evaluation of accuracy, reliability and operational suitability of missile guidance systems.

OPERATIONAL EVALUATION ENGINEER
Perform engineering studies and analysis of techniques for evaluating performance of missile guidance systems and its components including gyros, accelerometers, digital computers.

TEST SPECIFICATION AND PROCEDURES ENGINEER
Assess adequacy of test procedures, methods and test equipment in the major assemblies and complete fire control systems. Revise existing test procedures so that automated procedures and automated equipment may be utilized.

PROJECT ENGINEER — AIRBORNE EQUIPMENT
Guide and assist engineers in technical problems in field of electrical and electronic design, servo systems, missile guidance systems. Responsible for major product improvement program and test programs. Provide technical liaison with quality control. Heavy servo background desired.

GROUND EQUIPMENT ENGINEER
High degree of technical and administrative responsibility on complex projects involving the design and development of production test and field test equipment for gyroscopic systems and digital computers.

PRODUCTION TEST EQUIPMENT DESIGN ENGINEER
To administer and technically direct the design, development and manufacture of test equipment for production use in the manufacture, inspection and test of highly complex electronic equipment.

SYSTEMS EVALUATION (MISSILE GUIDANCE)
Perform functional engineering studies and design of inertial guidance systems, determine system and component requirements and performance, conduct system and component dynamic studies and simulation, perform error analysis.

GYRO DEVELOPMENT ENGINEER
Develop precision gyro systems including mechanical problems such as lubrication, temperature controls, hydrostatics, and vibration and electronic work on accelerometers, amplifiers, torquing circuits and electrical pickups.

PLATFORM ENGINEER
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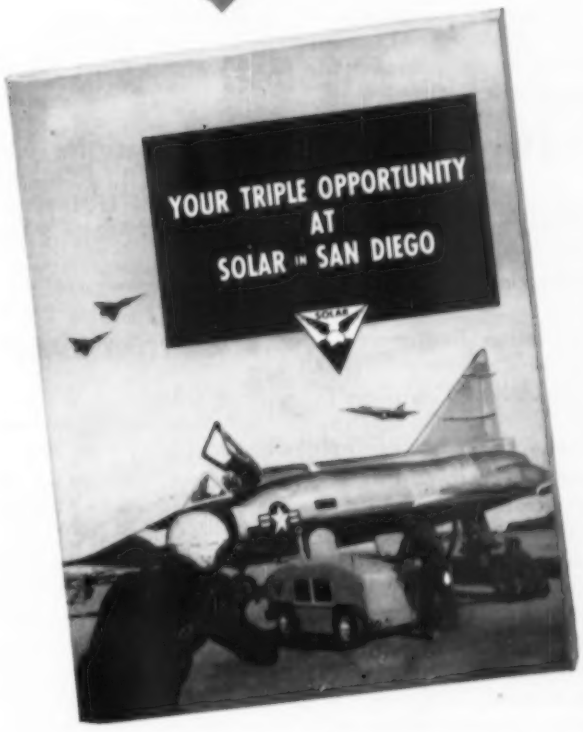

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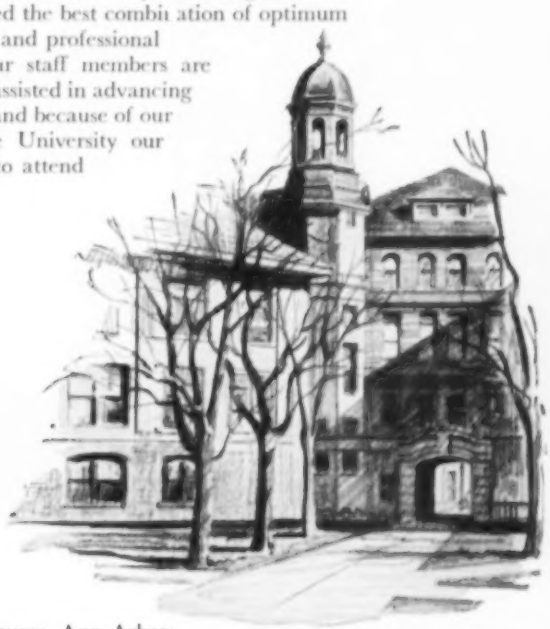

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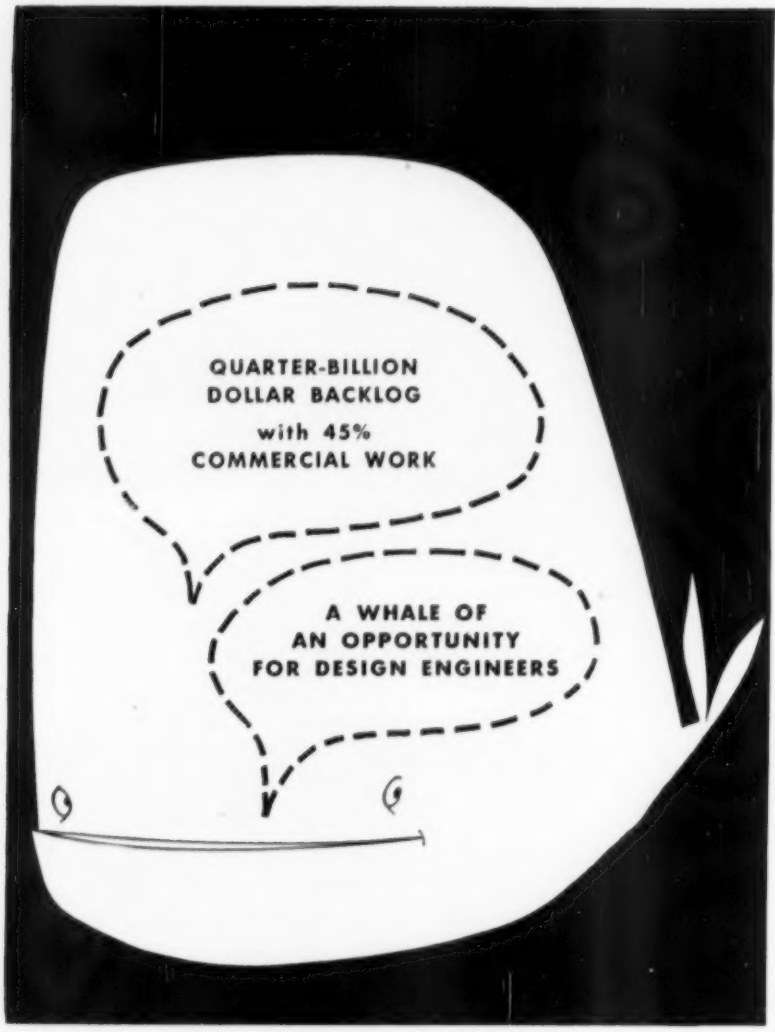

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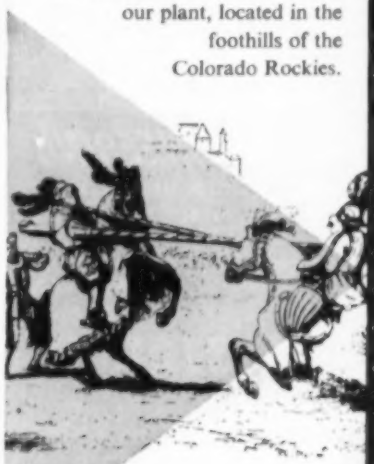

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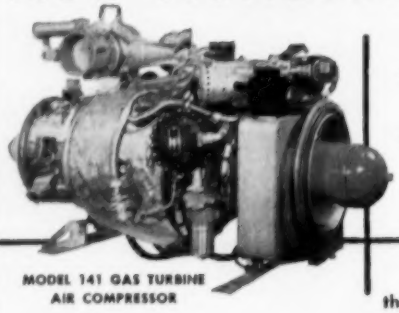

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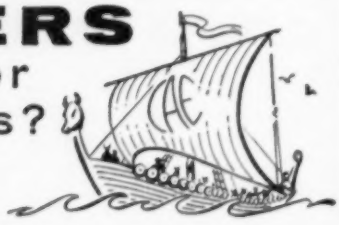

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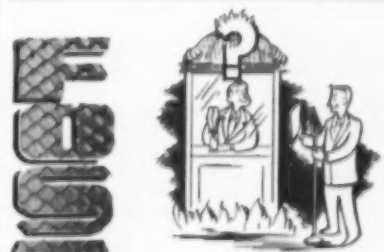

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LETTERS

Collision Comment

The amount of risk, work and expense involved in investigating the Grand Canyon accident is impressive. It seems a pity that the findings are then largely based on a thought reversal of a type that could be fatal to the pilots on whom the CAB sits in judgment.

Whereas the report states that study of the wreckage proves that the DC-7 approached at an angle of 25 deg. to the TAIL of the L-1049, the diagrams of the L-1049 windows and the estimates of the times the DC-7 was visible to the L-1049 pilots are based on the assumption that the angle of convergence was 25 deg. from the nose of the L-1049.

By turning around in his seat and pressing the left side of his face against the right side window the L-1049 copilot could have seen no closer than 30 deg. from the tail; therefore at the instant of the impact he could not have seen more than the right wing of the DC-7, below and outboard of his number 4 engine. At a closure rate of 18 kt. as indicated on the two flight plans, no part of the DC-7 would have been visible from the cockpit more than 4 seconds even if the copilot were looking as far forward as possible.

Since neither L-1049 pilot could reasonably have seen the DC-7, any evasive action must have been taken by the DC-7 and the L-1049 can be assumed to have been in a nearly normal altitude. If the L-1049 was in a left turn the DC-7 would have been in a steep dive and if the L-1049 had been in a normal right turn the DC-7 would have been in a very steep right turn (20 deg. more bank).

Except for this one glaring error, this appears to be a thorough report. However, it may bear mentioning that if either plane were climbing or descending the L-1049 may not have been visible from the DC-7 copilot's seat long enough for him to have taken any effective evasive action.

FLOYD E. MURRAY
Palo Alto, California

Irate Canadian

The letter from "Irate Passenger" in your May 13th issue was particularly interesting to me, but I would like to hasten to add Canada to any list of countries where airline passengers require protection of their rights against default by the airline.

The need is probably more acute here due to the virtual monopoly of most domestic routes except in Western Canada, as far as scheduled passenger services are concerned, by an airline owned by a railroad that is the instrument of the federal government.

Hence, to put it mildly, any competition is discouraged, even though on some domestic routes the airline sometimes advises would-be passengers that a flight is fully booked three weeks ahead.

In support of the airlines, though, it is my opinion that "double-booking" and "no show" passengers should pay a penalty —as they do in Europe—to assist in operational efficiency.

R. G. HUGGETT
Verdun, Quebec

Aviation Week welcomes the opinion of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

Opposes Cuts

During recent months efforts have been made to cut the national budget. As an economist for one of the larger corporations, I am opposed to such a cut at this time. I believe it would be unwise from an economic standpoint and a very serious blunder from a military angle.

The next few weeks are important in the history of this great nation of ours. No people in history has attained such heights of prosperity as we now enjoy. No other nation in the free world today is protected with comparable military security. The western world looks to America as a lasting bulwark against Communist aggression, as well as economic depression.

Today the Reds are in trouble. Communist plans for world domination have been disrupted. This has come about largely because America is strong in armed power, the only language the Communists recognize. At this highly critical period of military and economic progress, a segment of our people are screaming, "Let's cut taxes," which in the end means, let's cut our government's income and expenditures. We cannot reduce the one for a very long period of time without also reducing the other. A few politicians are capitalizing on the selfish interests of human nature, and embarrassing the administration with bills that would limit the federal income, and in effect would hamstring the Eisenhower administration.

Our government plans to spend $71.8 billion in the year starting July 1. This money will flow into every part of the country and will affect almost every business. The biggest slice of this budget will go directly to business firms—over $28 billion this year. The aircraft industry is largely dependent upon military orders for its existence, and this industry is one of the nation's largest. More than 800,000 workers in the aircraft industry owe their living directly to government orders. About $7.4 billion will be spent for aircraft and aircraft powerplants this year. Another $2 billion will go for guided missiles and still another $1.1 billion will purchase electronic equipment. About 60% of the $71.8 billion federal budget will go for defense. Any sizable cut in government expenditures will be in defense contracts, and unfortunately the most crippling effect will be in the research and development field. We cannot afford to lose the military race with Russia at this time when victory appears to be near at hand.

To realize an appreciable tax reduction for every taxpayer, government expenditures must be cut by several billion dollars. This reduction in purchases would have a downdrift effect upon the high level of our economy. Any rise in unemployment, or reduced working hours, will in turn result in a lower income for the government. Income is a critical factor right now. Prosperity has boosted the incomes of individuals and business and poured a rising stream of tax dollars into the government till. Individuals paid $41 billion in taxes on their incomes last year. A cut in military purchases could reduce this quickly. Let us face these facts. We must not cut the government budget at this time. The government needs tax dollars. You need prosperity and the free world is looking to us for military and economic security.

C. C. BRACKNEY, *Economist*
Hamilton, Ohio

So Much for So Little

Re: Surplus or Shortage (AW May 20, 1957), I wish to thank the Happy Jobshopper for giving me a few laughs after my returning from the salt mines.

With reference to engineers not handling engineering work, I heard a choice bit of supervisory logic today, which was in short: the supervisor felt that because he is responsible for any work leaving the group, he will do all the calculations involved and let the "engineers" do the peon work.

When we asked him why he doesn't stop by our work area once in a while to offer constructive criticism, the answer is that he is too busy. Who wouldn't be, while doing the thinking of 15 or more subordinates?

All in all though, I do thank Uncle Sam for subsidizing my existence, for where else but in an aircraft company, can one do so little for so much?

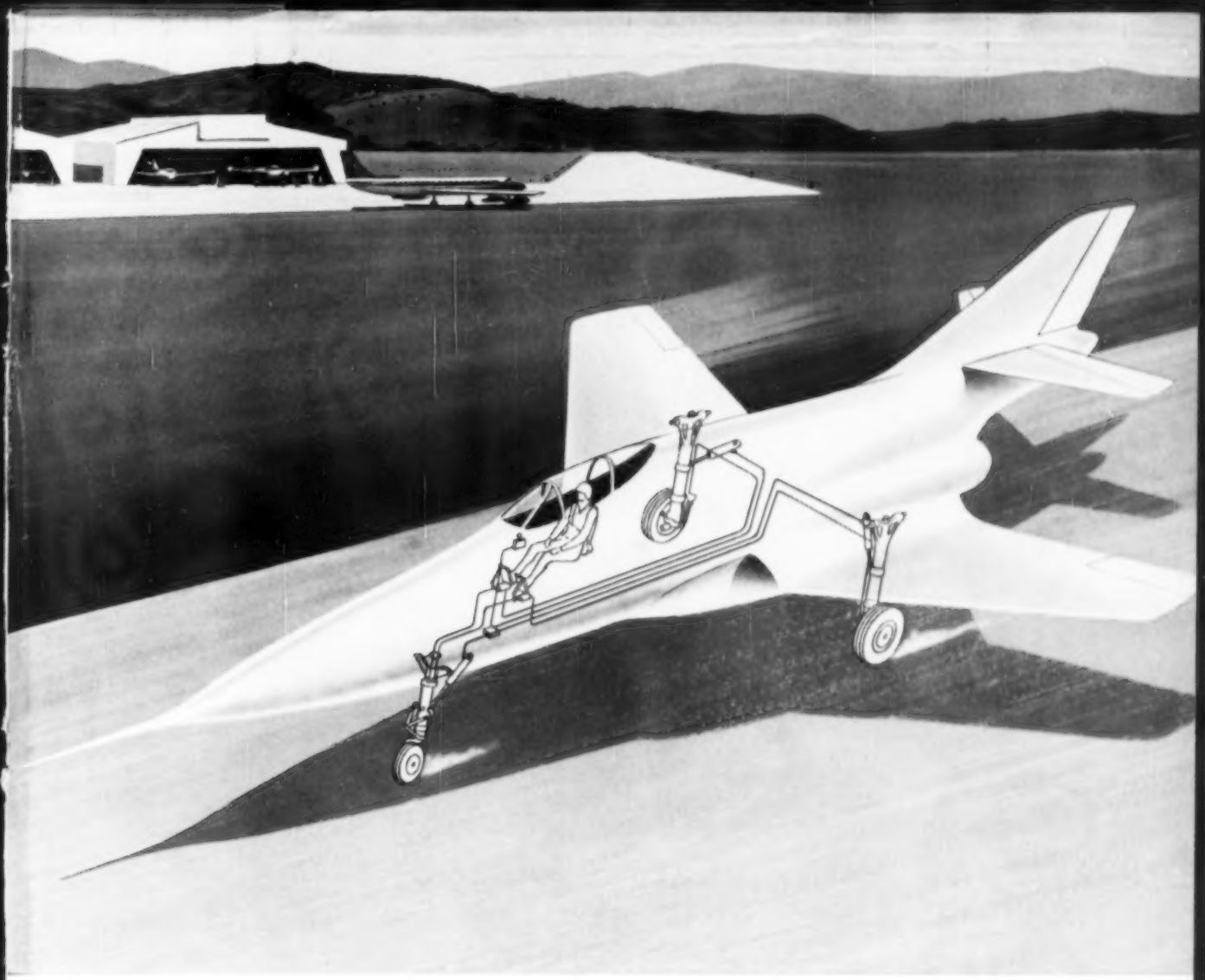
AN (UNHAPPY) HOMESTEADER

Takes Pride in Job

I will thank you for printing a short note of appreciation to T. O. McClure (AW April 15, p. 150) for his feelings regarding professional flight engineers.

We sincerely try to be highly qualified *technical assistants* to the pilots and the maintenance organization, and take pride in doing that job well. From my personal observation, more than 90% of us do our job along-side fellow crew members without any bitterness ("acrimony") of the type exhibited in the recent exchange of letters in your magazine written by the self-appointed mouthpieces of their respective groups.

R. A. WIEBOLDT
Huntington, N. Y.



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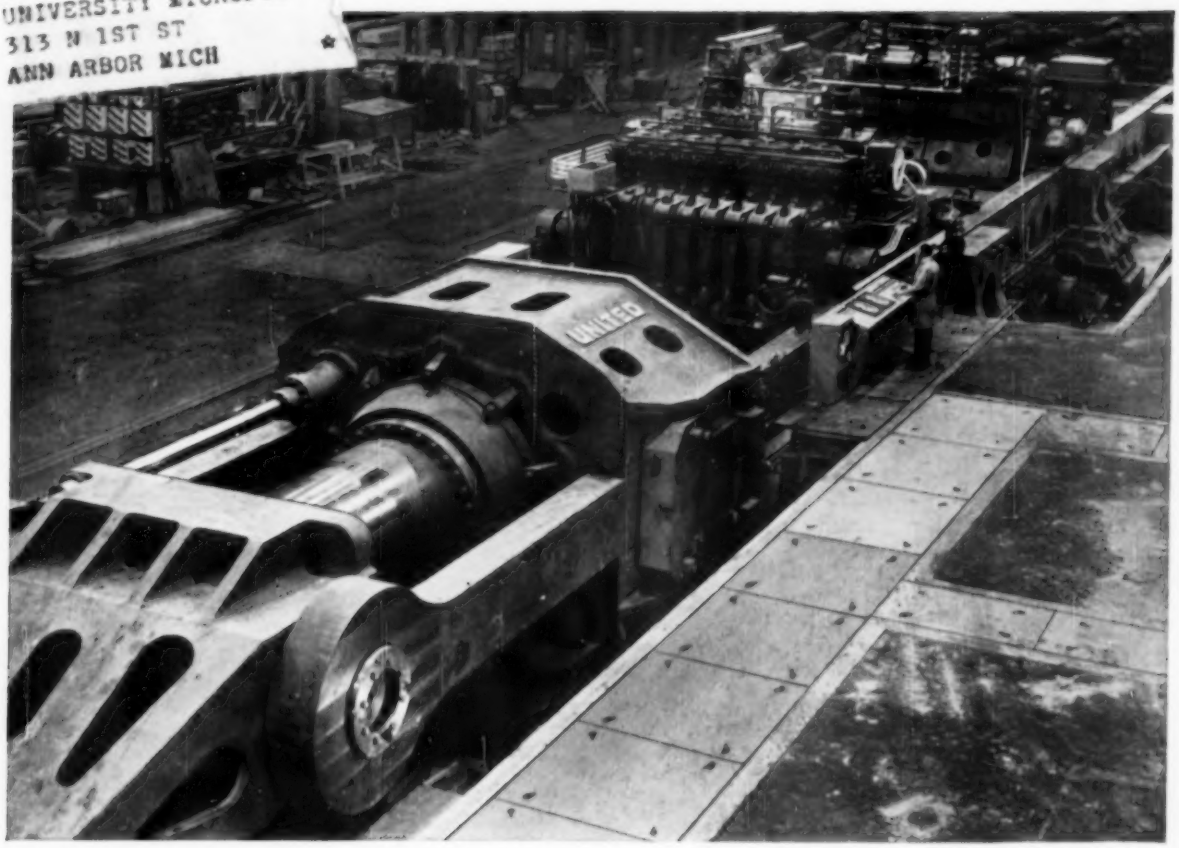

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